

# **REVIEW OF WASTE MANAGEMENT IN THE UK CONSTRUCTION INDUSTRY**

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## ABSTRACT

The construction industry is considered the world over as a major contributor to the high rates of waste generation in developed countries. The negative influence of waste generation on the environment, natural resources, and the profitability of firms puts increasing pressure on the industry to reduce the waste it generates. The pressures to reduce waste are heightened by current trends demanding sustainable management of waste for the purposes of economic, social, and environmental gains. Literature on factors influencing waste management (WM) suggests government legislation is the most critical success factor for ensuring waste is sustainably managed. A review of the literature however indicated that researches holistically investigating the practices of construction firms and the extent to which these practices meet the intended outcomes of government legislation on waste are not present.

Thus this research was undertaken to holistically investigate WM practices in the UK construction industry, to identify best practices and the extent to which they meet the intended outcomes of government WM legislation and policy. The study adopted a multiple case study design to examine WM approaches, strategies and practices at both the corporate and project level within construction companies. Four construction companies who had won awards for their sustainability and environmental performance were purposefully selected to investigate best practice WM. Data was collected through semi-structured interviews, passive observations, and documentary analysis. Analysis of the data revealed that the drivers for WM in the construction industry are: economic considerations; company sustainability agenda; company image; client requirements; environmental concerns; government legislation; moral and social demands; industrial benchmarking; environmental concerns; and the requirements of standards. Regarding the influence of legislation, the results revealed that government legislation plays a secondary role in influencing WM as clients are interested in using only compliant firms.

Best practices targeting design to reduce waste through standardisation and prefabrication; on-site segregation through multi-skip provision; supply take back schemes; intensified site education; and the use of incentives were identified to lead to improved WM. The results also indicated that company sustainability agenda is the most influential driver for achieving sustainable construction, demolition and excavation (CD&E) WM.

The findings highlighted the importance of having a clear vision and structure for WM at the corporate level alongside strategies to be implemented on projects to ensure sustainable WM is achieved. To help construction firms in achieving sustainable WM, which is the ultimate goal of government legislation, a best practice framework has been developed based on the findings from the study and evaluated using semi-structured interviews with selected target participants. The framework presents a coherent and systematic approach for achieving sustainable WM in construction companies by providing a roadmap for instituting measures at both corporate and project levels, taking into account factors that are likely to promote or inhibit the achievement of sustainable WM.

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**DEDICATION**

I dedicate this work to the Almighty God, creator of heaven and earth, who has been my rock, my strength, and my salvation and to the whole of my family.

## CHAPTER ONE

### GENERAL INTRODUCTION

#### 1.1 INTRODUCTION

One very common characteristic of developed countries is the high rate of waste generation (Martinez-Alier, 1995; Strange, 2002; Bogner, *et al.*, 2007) and it is said that a direct relationship exists between the level of development and the amount of waste produced (Bogner *et al.*, 2007, p.10). Waste can be defined as any material by-product of human and industrial activity that has no residual value (Serpell and Alarcón, 1998) and generally seen to be inevitable in any industry. The construction industry though a key industry for development is considered the world over as a major contributor to this high rate of waste generation (Lu and Yuan, 2011). The need to reduce the level of waste generation and the accompanying problems puts increasing pressure on the industry to reduce the waste it generates and the negative effects on the environment. Since the acceptance of sustainable development as a desirable concept (WCED, 1987), various initiatives have been taken to manage construction, demolition and excavation (CD&E) waste to the extent that CD&E waste management (WM) has become an established discipline worldwide (Lu and Yuan, 2011).

Research on the subject of CD&E WM reports that WM legislation is a critical factor to ensure the negative effect of CD&E waste on the environment is controlled (Osmani, Glass and Price, 2008). To meet the goals of waste legislation and also for the economic benefits CD&E WM promises, firms commit resources into WM practices (strategies). The review of CD&E WM literature however, failed to reveal any evidence of research taking a holistic view of how construction companies approach WM and the extent to which such approaches meet the intended outcomes of government interventions. Within the context of sustainable management of CD&E waste, this research focuses on establishing current best practices towards sustainable CD&E WM. This chapter presents an introduction to the research. The context of the research is presented and the research problem identified. The chapter describes the aim and objectives, justification, scope, research methodology and the contribution to knowledge. It concludes with a structural outline of this thesis which documents all activities of the research.

## 1.2 BACKGROUND

Construction by nature is not environmentally friendly (Shen and Tam, 2002). This is due to the nature of its activities which negatively affect the environment through pollution and the generation of high volumes of CD&E waste. Activities such as excavation, building and civil works, site clearance, demolition, road works, and building renovation lead to waste generation (EPD, 1998; Shen *et al.*, 2004; Tam and Tam, 2008). It is estimated that between 10–30% of construction materials are wasted (Stone 1983; Fishbein 1998) and waste from the construction industry makes up between 10 and 40% of all waste produced in any developed economy (Lu and Yuan , 2010).

Data from DEFRA suggests that 50% of the 200mt of waste generated in the UK in 2012 is from construction (DEFRA, 2015). In the US approximately 136 million tons of building-related CD&E debris is generated each year out of which only 20–30% is recycled (Sandler and Swingle 2006). In Australia, CD&E waste accounts for 16–40% of the total solid waste generated (Bell, 1998). In Hong Kong, about 2900 tons of CD&E waste (representing 23% of all solid waste) was received at landfills per day in 2007 (Hong Kong EPD, 2007). China produces 29% of the world's municipal solid waste (MSW) each year, of which construction activities contribute for nearly 40% (Dong *et al.*, 2001; Wang *et al.*, 2008 in Yuan and Shen, 2011a). These high rates of CD&E waste generation lead to concerns from governments, the general public and industry.

The concern for these high levels of CD&E waste is multiple fold: running up a large amount of land resources for waste landfilling (Poon *et al.*, 2003); harming the surroundings by hazardous pollution (Esin and Cosgun, 2007); wasting natural resources (Yuan and Shen, 2011b) and increasing the cost of construction projects. These concerns give rise to the need to find alternative materials or techniques that are less environmentally damaging to ensure the negative effects of waste on the environment as well as the use of raw materials is managed or controlled (Craighill and Powell, 1996).

Environmental management (EM) literature shows there is the need to control the pollution of the environment and the management of resources to ensure sustainable development is achieved (El-Kholy, 2001: 15 in Barrow, 2004, p.12; Bogner *et al.*, 2007, p.10). Efforts in

EM have been channelled at decoupling environmental pollution from the level of development and a key aspect of this is the management of waste. In this regard, the construction industry is considered key because of the environmental and social impacts that occur at each stage of the construction ‘lifecycle’, from the extraction of raw materials, through processing, construction, demolition and recycling, to final disposal (Craighill and Powell, 1996).

From WM literature, Government is considered a key factor in controlling the effects of waste generation on the environment through the use of WM policies and legislation (Osmani, Glass and Price, 2008). In the construction industry, WM legislation is considered a critical success factor (CSF) for the management of CD&E waste (Osmani, Glass and Price, 2008; Jallion and Poon, 2008; Lu and Yuan, 2010; Wang *et al.*, 2010).

Waste legislation in the UK is derived from the EU regulatory framework (Burch, 2005; Jordan, 2006). The overarching legislative framework for WM in the EU is the EU Waste Framework Directive (WFD) (Directive 2006/12/EC on waste) which sets the obligations for member states on the collection, transport, recovery and disposal of waste. Currently amended by the Waste Framework Directive 2008 (Directive 2008/98/EC), it sets the obligation for member states to take appropriate measures to encourage firstly, the prevention or reduction of waste production and its harmfulness and secondly the recovery of waste by means of recycling, re-use or reclamation or any other processes with a view to extracting secondary raw materials, or the use of waste as a source of energy (DEFRA, 2012). Other Directives which affect CD&E WM are the Landfill Directive (1999/31/EC) and the Integrated Pollution Prevention and Control Directive (IPPC) (2008/1/EC). The aims of EU waste legislation are promoted by EU WM principles and the EU waste hierarchy (Peng *et al.*, 1997; Clinch, 2000; Strange 2002).

In the UK, a number of regulations exist which transpose the requirements of EU waste legislation into UK law. Notable among them with particular reference to England and Wales are the Wastes (England and Wales) Regulations 2012, Environmental Permitting (England and Wales) Amendment Regulation (EPR) 2012, and the Site WM Plans (SWMP) 2008 regulations (repealed in December 2013). All these waste regulations

impose obligations on construction firms which demand the devotion of resources (which come with cost implications) to meet regulatory goals. Whereas sceptics regard WM regulations as major burdens on industry and business (little other than red tape) (Fergusson and Langford, 2006; Baldwin, Cave and Lodge, 2011), for supporters, it is good for the industry as it promises economic advantages and a green light that can lead to innovation (del Río Merino *et al.*, 2010; Baldwin *et al.*, 2011).

The legislative framework for CD&E WM is shaped by sustainable development concerns such as: the need to reduce the level of pollution of the environment; the need to reduce the over reliance on and depletion of natural resources; and running out of space for waste land filling. To achieve sustainable development, which advocates efficient allocation of resources and improved quality of life (Ofori, 1992), the EU waste legislation and policy set the goal to ensure 70% of all CD&E waste is reused, recycled or recovered by 2020. In the UK, the local targets are: to ensure a 50 per cent reduction of construction, demolition and excavation waste to landfill by 2012 in relation to 2005 levels and zero waste to landfill by 2020.

To meet the targets of waste legislation and for the economic benefits of CD&E WM, construction firms engage in various WM practices. The practices target reducing or preventing materials from becoming waste, reuse of materials from waste which could not be prevented, recycling of materials which could not be reused, recovery of the value in waste materials, and the disposal of materials which could not be redeemed by any of the other activities (Jaillon *et al.*, 2009). To meet these targets, CD&E WM practices pursued include, but not limited to, waste source evaluation and sorting (Cheung and Peon, 1996; Poon *et al.*, 2001; Wang *et al.*, 2010), training of site workers (Begum *et al.*, 2007), the use of site WM plans (SWMP) (McDonald and Smithers, 1998; Poon *et al.*, 2004; Tam, 2007), preparing materials for reuse (Begum *et al.*, 2007; Da Rocha and Scattler, 2009), and waste recycling (Merino *et al.*, 2009; Strufe, 2005; Tam and Tam, 2006).

Literature on CD&E WM shows that firms, in the absence of regulation, would only pursue WM practices that directly impact on profit (Christmann, 2000; Morrissey and Browne, 2004). It is expected therefore, that economic considerations will remain a critical

factor regarding WM practices regardless of legislative requirements. The fragmented nature of the construction supply chain demands a supply chain approach to CD&E WM which requires all stakeholders to take necessary steps to ensure WM legislation and policy goals are met. Research on the subject of CD&E WM, report that government intervention through WM legislation is one of the most critical factors to ensure the negative effects of waste on the environment are controlled (Osmani *et al.*, 2008; Jaillon and Poon, 2008; Wang *et al.*, 2010; Yuan, 2013). The EU since 1992 has regarded CD&E waste as a priority waste stream leading to upsurge in WM legislation and increased pressure on the industry to manage waste.

Though there are a lot of studies on the WM practices/strategies of construction firms, review of the literature failed to reveal any evidence of research into the extent to which the intended outcomes of government interventions are being met by the current practices.

### **1.3 RESEARCH AIM AND OBJECTIVES**

The aim of this research is therefore to investigate current practices of CD&E WM in relation to the extent to which they meet the intended outcomes of legislation and relevant policy documents and to suggest an agenda for improvement action. To achieve this aim requires pursuit of the following objectives:

1. review of environmental and sustainability concerns influencing the development of WM legislation and policy;
2. identification of relevant legislation and policy statements applicable to CD&E WM in the UK and their intended outcomes;
3. establishment of the key elements of current CD&E WM practices in the UK and development of measures of CD&E WM outcomes;
4. production of a conceptual framework for assessing how CD&E WM translates into practice and the extent to which the intended outcomes of the legislative or policy interventions are being met by current practices;
5. collection of relevant data on WM to determine the policies of firms towards waste management, how they translate into practice to meet the intended outcomes of legislation, and identify gaps in performance and management practice; and
6. identification of appropriate remedial action for deficient CD&E WM practices and development of strategies for improvement action.

## 1.4 RESEARCH QUESTIONS

The fundamental questions this research seeks to address are:

- how does the CD&E WM legislation and policy in the UK translate into practice? – what are the policies of firms, and what resources are employed to meet the legislative demands?
- what roles are played by the major stakeholders in meeting the legislative goals?
- currently to what extent have the goals of the interventions been achieved by the firms?
- how adequate are the practices of construction firms in meeting the targets set by the legislative framework?

## 1.5 SCOPE OF THE STUDY

This research is limited to CD&E WM in the construction industry in the UK with emphasis on England and Wales. Though WM legislation in the UK covers many waste streams, this research is limited to CD&E WM. The review of literature however is not limited to the UK only as the problems of CD&E WM as well as practices are almost uniform in all developed countries. WM legislation as used in this report shall be taken to mean regulations relevant to the management of CD&E waste, and as such other regulations or frameworks on waste that do not relate to construction, demolition and excavation waste are excluded. Though the study area is limited to the UK, EU waste framework directives as mentioned in this study apply to all member countries of the EU.

## 1.6 RESEARCH JUSTIFICATION

The problem of waste generation in the construction industry is regarded the world over as a negative influence on our environment and the goal currently is to use the best environmental methods to ensure there is little or no damage to the environment. CD&E waste generation does not only affect the environment but has effects on sustainable development as well as cost implications for construction firms through increase in the cost of construction projects. Under sustainability considerations, CD&E waste generation (material mismanagement) leads to excess use of natural resources which could be preserved, and the take up of large spaces of land for waste landfilling. These concerns that influence WM legislation result in obligations on firms which demand the allocation of resources to meet such obligations. In an industry where price/cost is a major factor, there is the need to ensure that management efforts are both efficient and effective.



According to the review of CD&E WM literature by Yuan and Shen (2011), studies assessing the ability of CD&E WM practices in meeting the legislative goals are missing in the literature. Such studies when available will help in directing future research on how to enhance the efficiency and effectiveness of CD&E WM practices. The need for such studies becomes relevant in the wake of increased legislation on the management of CD&E waste which is seen as a burden on the construction industry – competing with other activities for limited resources. For the construction industry in the UK and elsewhere, this study will identify how to achieve the best outcomes from WM practices and make recommendations on strategies for improved action, taking into consideration legislative and policy goals as well as economic implications.

There is also the need to ensure that the industry is on course to meeting the targets as set by UK waste policy to ensure a zero waste industry by 2020. To Regulators, this study will provide information on enforcement strategies targeted at meeting the intended goals of CD&E WM legislation that can serve as inputs for subsequent legislation on CD&E WM and WM in general. This study shifts away from the usual compliance enhancing approaches which according to Mitchell (1996) does not necessarily mean that the intended goals of legislation are being met.

To the CD&E WM scholarship, this study intends to fill the gap in assessing the extent to which CD&E WM practices are meeting legislative intended outcomes and make recommendations for further studies.

## **1.7 RESEARCH DESIGN**

To answer the fundamental questions posed by this research, a qualitative approach to research which is based on an interpretivist research paradigm was adopted. According to Creswell (2008), a qualitative approach allows one to have an in-depth study into a particular phenomenon to answer questions of ‘how’ and ‘why’ (see also Walker, 1997). To have an in-depth view of CD&E WM practices of UK firms and how they meet the expected outcomes of government legislation, a multiple case study approach which allows the investigation of real world phenomenon within its natural context (Creswell, 2007; Yin, 2013) was followed. As reported in Proverbs and Gameson (2008), the use of case studies is very relevant in the construction industry; a project driven industry made up of many different types of organisations and businesses. The use of multiple case studies gave a

holistic view of the subject (Barbour, 2001; Ghauri and Grønhaug, 2002), and allowed for the use of multiple sources of data. The use of multiple sources of data helped to achieve triangulation of results, which ensures the quality of the evidence, generates strong evidence in support of key findings (Simons, 2009), and makes the findings more reliable (Yin, 2013). The research framework, which gives a summary of the research design, is shown in figure 1.1.

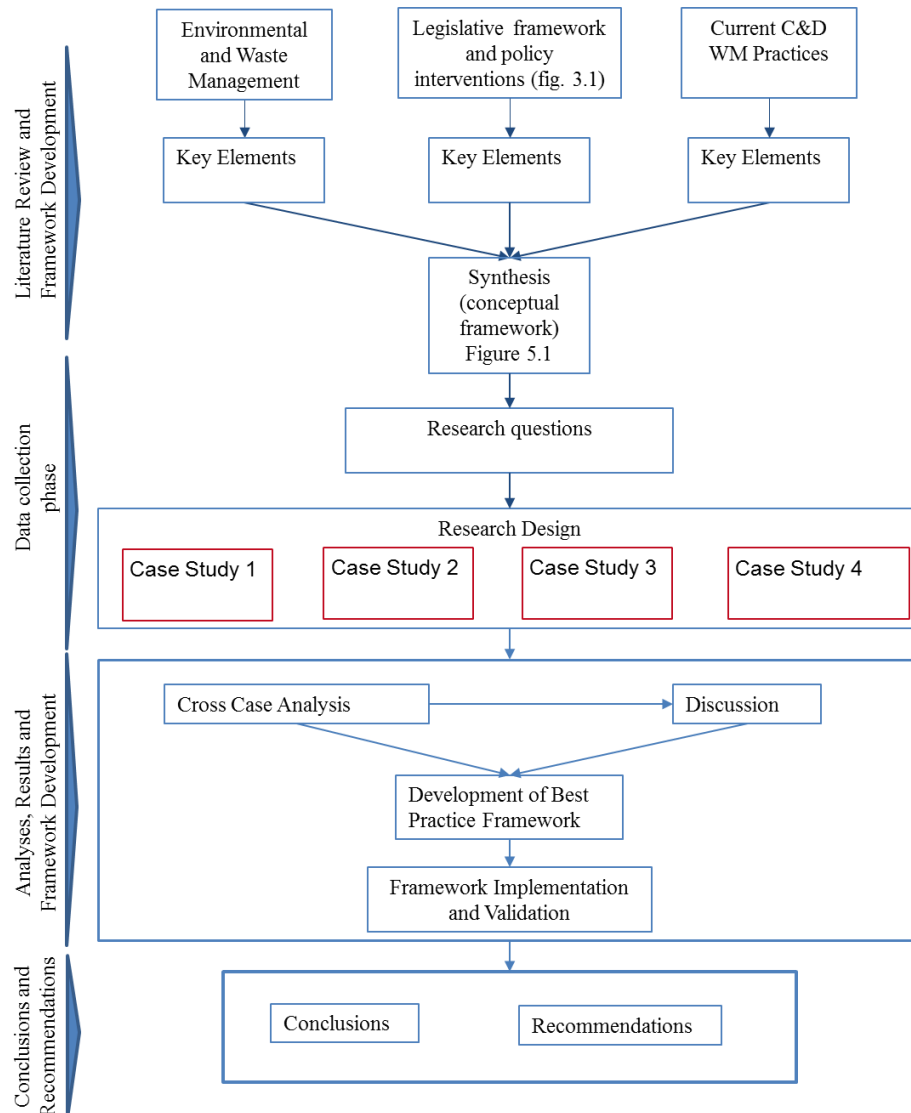


Figure 1.1: Research Framework

From a synthesis of the major issues identified in the literature, a conceptual framework, for measuring the extent to which current CD&E WM practices meet the intended goals of WM legislation was first developed. This formed the basis for the design of the research instruments. Data collection was based on the use of multiple case studies with embedded

units of analysis (Yin, 2013) involving four companies awarded for their environmental management and sustainability performance in 2013 to help in gathering best practices from the industry. Data collection was by means of in-depth interviews with a total of 43 corporate and project level staff; site visits (observations) to nine (9) live construction projects; and analysis of company documents.

Data analysis involved organising and coding the data, qualitative content analysis and thematic analysis with the help of the qualitative data analysis software NVivo 10. The findings of the research led to the development of a best practice framework for sustainable management of construction, demolition and excavation (CD&E) WM. To ensure the usefulness of the framework to the industry, the views of selected sustainability, environmental, project managers and other construction professionals were used to validate the relevance of the framework.

## **1.8 SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSIONS**

The findings of the study are presented in this section in three main parts. The first part discusses the drivers of sustainable CD&E WM and role played by government legislation. The second part describes the process of achieving sustainable CD&E WM. The third part discusses the factors likely to influence the efforts of construction firms towards achieving sustainable CD&E WM. The final part examines recommendations for improvement in the quest for sustainable CD&E WM.

### **1.8.1 Drivers for sustainable CD&E WM and the role of government legislation**

The findings of the study suggests that nine main drivers divided into internal and external are responsible for driving construction firms to manage waste. Internal drivers which are determined by the firms include: economic considerations; company sustainability agenda; the quest for a good image; social and moral imperatives to manage waste; and concerns for the environment (see section 8.4). Factors driving waste external to the control of construction companies are: demands of clients; industrial benchmarking; government waste management legislation; and the requirements of standards (see section 8.4.). The study found that for most construction companies, the key internal driver for managing waste is the need to reduce the cost of waste generation to their projects. This is the

recognition in most companies that waste generation has a very high impact on their profitability. For some companies the cost of waste is as high as 0.5% of total company turnover and the need to reduce the cost of waste drove waste management. The need for a good image as a contractor; concerns for the environment; and social and moral imperatives for managing waste fuel company sustainability agenda as the next most important internal driver for WM. The demands of clients, especially sustainability inclined clients, for certain levels of performance drives companies to manage waste. The quest to compare performance against other competitors and to meet the requirements of standards companies subscribe to make industrial benchmarking and standards drivers of waste management. The influence of government legislation in driving WM is identified to occur through a secondary means. For most companies, persecution for non-compliance gives a negative image which negatively affects their chances of winning contracts, especially from sustainability aware clients.

For achieving sustainable CD&E WM, the most influential driver is company sustainability agenda which seeks to ensure companies contribute positively towards the environment by integrating all the other drivers for WM.

### **1.8.2 Means to achieve sustainable CD&E WM**

Analysis of the data disclosed that achieving sustainable management of CD&E waste requires a conscious effort from construction companies at both corporate and project levels. As reported in section 10.2.2.2, achieving sustainable CD&E WM begins with companies having a clear vision for WM and putting in place a management structure to ensure the vision is translated into achievable goals. This requires the management teams set up for the purposes of WM to set targets for WM which may be reviewed periodically. To achieve the targets, the results suggest approach waste management through design, procurement, and construction strategies. Strategies towards waste management at the corporate level include: planning, governance; outsourcing; training and education for WM; monitoring of performance; and preparing of documents to aid WM (see section 10.2.4).

To ensure the corporate level approaches and strategies translate into achievements on projects, there is the need to have a management team on projects for the purposes of WM. This team must be involved very early as part of the project team and must be able to set strategies for: waste reduction; waste reuse; waste recycling; waste recovery; and waste

disposal (see section 9.4). Common practices to achieve these include: design to reduce waste by using standardized shapes and forms, and design for prefabrication; planning for WM on projects; management of special waste by the use of specialist sub-contractors; deconstructing existing structures to salvage valuable materials; use of cutting sheds for waste reduction and reuse; training of site staff to identify waste reduction options; segregating waste for reuse and recycling; use of charging schemes to make sub-contractors manage waste; and performance monitoring on projects. Of all these strategies, design to reduce waste was identified to have the most influence on waste reduction.

### **1.8.3 Factors influencing the extent of waste management**

At the project level, a number of factors were identified to either promote or inhibit the extent to which sustainable WM could be achieved on projects. These factors include: the ability to make corporate agenda influence project level WM; availability of resources; attitudes of site teams towards WM; attitudes of senior management on site; the ability to identify avenues for WM; the type of construction technology used on-site; standardization of components; complexity of design forms; relationship with manufacturers; programming of works; size of project; understanding of the demands of WM; availability of space on-site; early planning of the project; the level of WM education on projects; and the stage of projects. The research suggests that construction companies should put measures in place to convert these factors into enablers of sustainable WM.

### **1.8.4 Recommendations for improvement**

Combining the best practices captured from the corporate as well as project level of the four companies used for this research, a best practice sustainable CD&E WM framework has been designed as a road map for construction companies to pursue sustainable CD&E WM (see Chapter 11). A step by step guide for implementing the framework has also been provided. Results from the evaluation of the framework based on selected the views of selected sustainability managers, environmental managers, and environmental advisors suggest that the framework: presents a useful resource for WM; has very good recommendations that can translate into improved waste management on projects; and will be able to guide construction firms plan and put in place structures for achieving sustainable WM.

## **1.9 STRUCTURE OF THE THESIS**

This thesis is divided into twelve chapters as shown in figure 1.2. A summary of the key elements in each chapter is given below.

### **Chapter 1 Introduction to the research**

This chapter presents an introduction to the research as well as the background information to the research and identifies the research problem. The chapter describes the aim and objectives, justification, scope, a snippet of the research design and a guide to the thesis.

### **Chapter 2 Environmental Management, Sustainability and the Construction Industry**

Chapter 2 presents a critical review of the development of environmental management, sustainability as well as WM and the role the construction industry has to play in all these areas and concludes with a framework of environmental management and sustainable development within the construction industry.

### **Chapter 3 Regulatory Environment for Waste Management**

This chapter reviews environmental as well as WM legislation in the UK and analyses the core principles as well as aims of WM legislation within the UK. The chapter concludes with a legal framework for CD&E WM in the UK and the EU depicting how UK national laws transpose EU waste Directives.

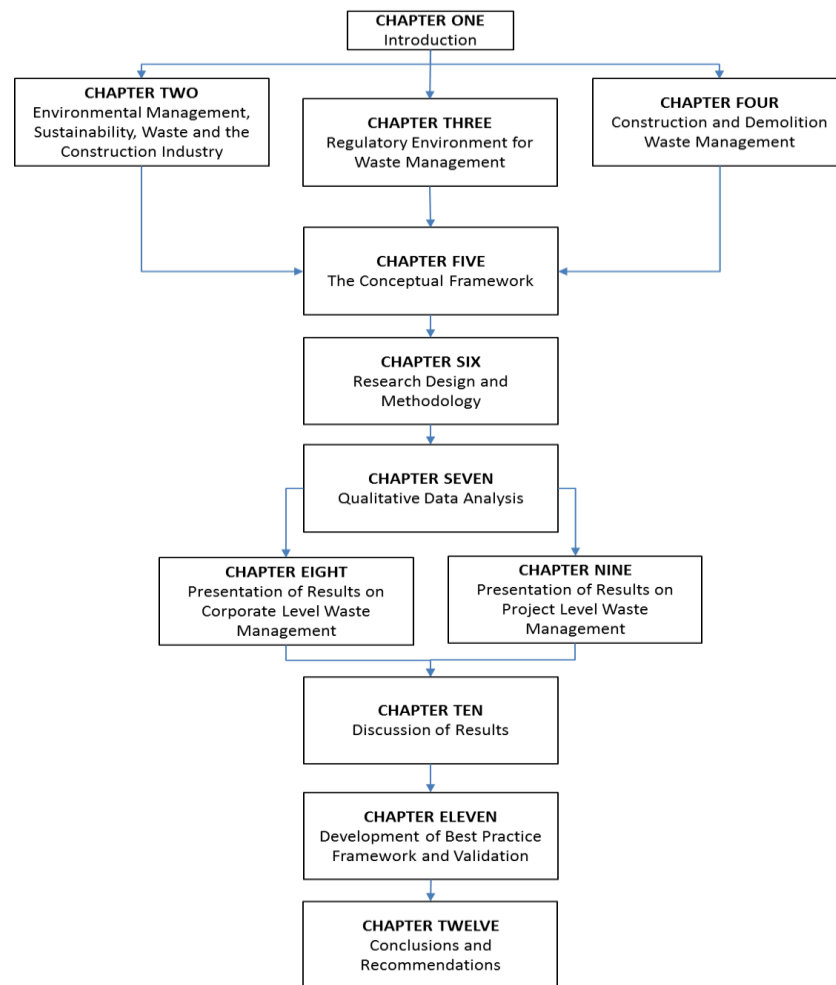


Figure 1.2 Thesis structure

## Chapter 4 Construction and Demolition Waste Management

Chapter 4 critically reviews literature on CD&E WM studies to paint a clear picture of the field of CD&E WM and what the future direction for the research areas looks like. This review also identifies the gaps in literature that this research seeks to fill.

## Chapter 5 The Conceptual Framework for the Study

A conceptual framework for the research, which links the various sections of the research to find the interrelations between environmental management and sustainability, WM legislation, and CD&E WM, is developed in this chapter.

## Chapter 6 Research Design and Methodology

In chapter 6, a review of research design is made to help select the most appropriate approach for conducting this research. The chapter justifies the choice of method for collecting and analysing the data and as well as ethical requirements for the research.

**Chapter 7 Qualitative Data Analysis**

In this chapter, an in-depth discussion of the methods adopted for data analysis is presented. It explains the process of transforming the data collected (coding), the building of themes and sub-themes, and the display of data using charts and tables.

**Chapter 8 Presentation of Results on Corporate Level CD&E WM**

This chapter presents results from the corporate level of all four case study companies on corporate level WM visions, strategies and approaches.

**Chapter 9 Presentation of Results on Project Level WM**

This chapter presents results from the analysis of data on WM at the project level. It presents results on project level WM vision, drivers for WM at the project level, approaches towards waste at the project level, strategies and practices to manage waste, factors influencing WM on projects as well as the waste streams identified on projects sites.

**Chapter 10 Discussion of Results**

Chapter 10 discusses the results of the analysis on both corporate and project level WM in chapters 8 and 9 and makes interpretations of the outcomes of the study, as well as the implications of the results. This chapter also discusses the results using extant CD&E WM literature to determine how the findings of this research relate to previous works in the field.

**Chapter 11 Development and Evaluation of Best Practice Sustainable CD&E WM Framework**

Based on the outcome this research, this chapter presents the development of a best practice framework for sustainable CD&E WM drawing from the best practices captured from the case studies. The chapter also presents results from the evaluation of the framework and the implementation guidelines for the framework.

**Chapter 12 Conclusions and Recommendations**

This is the last chapter of the thesis and provides a summary of all the steps taken to achieve the objectives of this study. The chapter also highlights the contributions of this



study to theory, methodology and industrial practices and the practical implications. The chapter concludes with the limitations of the study and makes recommendations for further studies.

## **1.10 CHAPTER SUMMARY**

This introductory chapter has presented the background to this research and provided the aim for conducting the study into the construction and demolition WM practices of construction firms in UK. The chapter has discussed the objects for achieving the aim of the research, the research questions, scope and the justification for conducting this research. The chapter has also given some information on the research design adopted for this research and the outline of the thesis.

Following this chapter, chapter two, presents the first part of the literature review which concentrates on environmental management, sustainability, waste and the construction industry.

## **CHAPTER TWO**

### **ENVIRONMENTAL MANAGEMENT, SUSTAINABILITY, WASTE AND THE CONSTRUCTION INDUSTRY**

#### **2.1 INTRODUCTION**

The construction industry is considered one of the major users of natural resources the world over. It is tagged as non-environmentally friendly due to its the extraction of environmental resources like fossil fuels and minerals; consumption of generic resources, namely, land, water, air, and energy; the production of waste that consumes land for disposal; and pollution of the living environment with noise, odours, dust, vibrations, chemical and particulate emissions, and solid waste generation (Shen *et al.*, 2004).

This chapter reviews the literature on the concept of environmental management and sustainability and their relationship with CD&E WM. The evolution of environmental management and sustainability are traced, the current state of these concepts is discussed and how WM in the construction industry can contribute to help achieve sustainable environmental management is considered.

#### **2.2 ENVIRONMENTAL MANAGEMENT**

There is the need to ensure a reduction in the negative effects of human activities on the environment. This need leads to calls for decoupling development from environmental harm or pollution (Bogner *et al.*, 2007, p.10). One way to achieve this is environmental management. The goal of environmental management is to ensure there is sustainable use of resources and at the same time better management of the effects of human activities on the environment (El-Kholy, 2001: 15 in Barrow, 2004, p.12), by achieving a global balance and if possible improving people's wellbeing (Barrow, 2004, p.9). Environmental management is in line with the concept of 'sustainable development' which advocates for

continued economic growth and rise in living standards while acknowledging that economic growth must be within the limitations of the earth's carrying capacity (Hale, 1995). One major effect of human activities on the environment is the production of waste. The control of the production and management of this waste is a major goal of environmental management.

### **2.2.1 History and development of Environmental Management**

This section traces the history and the development of environmental management to help inform a better understanding of the demands of the concept and its current contribution to sustainable development.

#### **2.2.1.1 Evolution of Environmental Management**

Although the environmental movement can be traced back to much earlier origins, it began in earnest in the 1960s with legislators passing laws and creating regulatory agencies and with citizen-centric advocacy organizations campaigning for stronger public health standards and biodiversity conservation (Chertow and Esty, 1997; Fiorino, 2001; Durant *et al.*, 2004). Concerns for better management of the activities of industry on the environment started when research suggested that the rate of depletion of natural resources (by development) would lead to a time when the environment cannot sustain the development of life any more (Barrow, 2004, p.8). Meadows *et al.*, (1972) studied '*The Limit to Growth*' and suggested that human demands could outstrip global limits unless there is developmental and environmental management. Environmental management during this time was a low priority area as nature was generally regarded as unlimited and resilient, and environmental management promised limited profit (Barrow, 2004, p.6).

Before the 1970's developmental efforts mainly focused on poverty reduction and concerns for the environment were seen as a luxury the poor could not afford (Martinez-Alier, 1995). Only few nations bought in to the idea of environmental management and there were only 10 ministerial level departments of environment in the world in 1970 (Ausubel *et al.*, 1995 in Keene and Pullin, 2011). Environmental concerns rose between the 1960s and 70s when pollution had become a problem mainly due to the careless use of

technology (Chertow and Esty, 1997; Fiorino, 2001; Durant *et al.*, 2004). During this time, there was the view that humans have a limited time to set in motion development that will sustain the world's people indefinitely with a satisfactory quality of life (Caldwell, 1977:98; Berger, 1987:116; Ghai and Vivian, 1992 in Barrow, 2004, p.8). This viewpoint was partly promoted by Meadows *et al.*'s 'Limits to Growth' (Ofori, 1992) which warned that human development could lead to catastrophic consequences unless there is effective environmental and development management.

By the UN Earth summit in 1992 (held in Rio), there had been a significant change in attitudes towards the environment. Though the Rio 'Earth Summit' was less successful in generating workable conventions and agreement (Athanasίου, 1997:8), it is what has gradually led to a more sustained effort towards the fight for environmental sustainability. The degradation of the environment is now a major concern of governments, the public, educators, and (increasingly) business and industry (Hale, 1995). The first international discussion on environmental issues was the United Nations meeting on Human Development in Stockholm. The 1972 Stockholm Conference signalled the internationalization of the problem of environmental disruption (Colby, 1989). The discussion by the Unit Summit on environmental management led to the setting up of the UN environmental agency in 1973. Significant developing country involvement in the environmental management crusade however started in the 1980's. Advocacy for the environment got stronger between this time and 1992 and many nations began to set up environmental ministries and departments to better manage the issue of environment. According to Barrow (2004 p.7), advocacy for proper environmental management became high around 1987 and since then has been taken a lot more seriously by nations.

It is advocated that Environmental management must watch for all threats, accurately assess which are genuine, decide priorities, and then strive to get appropriate actions to avert or better survive problems (Barrow, 2004, p.10; Ofori 1992). According to Trzyna (2008), almost all the national governments of the world now have at least two agencies with environmental missions: one for environmental protection and one for natural resources management.

### **2.2.1.2 Theories, and development of environmental management**

Many theories have influenced the evolution of the environmental management agenda over the years. The concept of environmental management deals with the management of the interaction between humans and the natural environment to ensure the adverse effects of human activities on the environment is reduced. According to Erickson and King (1999), the concept and goal of environmental management is to make deliberate efforts to steer the development process to take advantage of opportunities, and to ensure no critical limits are exceeded, avoid threats, mitigate problems, and prepare for unavoidable difficulties by improving adaptability and resilience. Hale (1995, page 21), defines environmental management as “the wise use and management of resources which is not only cost effective but limits the unnecessary degradation of environmental resources upon which the whole of humankind depends”. El-Kholy (2001, p.15), defines environmental management as a process that is concerned with human-environment interactions and seeks to identify what is environmentally desirable, what are the physical, economic, social and technological constraints to achieving it and what are the most feasible options.

A key aspect of all definitions is the anticipation or identification of problems that are likely to hinder the achievement of desirable environmental goals. Environmental management can therefore simply be defined as management efforts aimed at identifying and mitigating problems likely to hinder the achievement of environmental protection and resource conservation.

## **2.3 SUSTAINABLE DEVELOPMENT**

According to Robinson (2004), sustainable development is a logical extension of the arguments within the environmental literature of the 1960s 70s and early 80s. The development of the concept was favoured by the Brundtland Report (World Commission on Environment and Development, 1987) which helped propagate and establish its concepts (Royal Tropical Institute, 1990; Ercal, 1991). The concept of sustainable development became part of environment and development discourses by the twenty first

century, and various authorities have noted that it is a concept that helps integrate environmental management and development management. Sustainable development is seen as an attempt to bridge the gap between environmental concerns about the increasingly evident ecological consequences of human activities and socio-political concerns about human development issues (Clark and Munn, 1986). Sustainable development is simply defined as the ‘comprehensive assessment of all the costs and benefits of economic activities including externalities, to obtain an efficient allocation of resources and an improved quality of life’ (Economic Commission for Europe, 1990 in Ofori, 1992).

The growing concern for environmental quality and interest in pursuing sustainable development has prompted the inclusion of sustainability or environmental indices into development measurement (Barrow, 2004, p.16). According to Colby (1989), developmental approaches that fully integrate environmental, technological and social systems offer synergetic economic, social and ecological benefits and this is what sustainable development seeks to achieve.

Industry is recognised as an essential aspect of development and wealth creation (Azapagic, 2003) as it is the engine on which the development agenda is run. Industry, though an essential aspect of development is recognised as a source of environmental degradation and social concerns. As an important social sector, industry must play a prominent role in creating a sustainable future (Azapagic and Perdan, 2000). The need to manage the impact of industry on the environment led to the challenge of sustainable development. This challenge is how businesses will be able to contribute to a better quality of life without compromising the quality of the environment for the present and future generations (Azapagic, 2003).

The concept of sustainable development is said to be in line with the principle of intergenerational equity which states that “each generation has an obligation to future generations to pass on the natural and cultural resources of the planet in no worse condition

than received and to provide reasonable access to legacy for the present generation” (Weiss, 1989 in DeMarco, 2008).

## **2.4 THE CONSTRUCTION INDUSTRY AND THE ENVIRONMENT**

The construction industry, though a contributor to infrastructural development affects the environment in so many different ways. Different authors have looked at the industry’s effects on the environment from different angles and the literature suggests that the impact of the construction industry on the environment does not only cover the construction phase of projects but begins as early as the production of materials for the industry, through transportation, to construction, use and at the end demolition of the constructed products (roads, buildings etc.). March (1992 in Shen and Tam, 2002)), observed the construction industry’s environmental impacts under the categories of ecology, landscape, traffic, water, energy, timber consumption, noise, dust, sewage, and health and safety hazards. According to Spence and Mulligan (1995 in Uher, 1999), the impact of the construction industry on the environment is considerable particularly in areas of energy use, soil degradation, loss of agricultural land, forests and wild lands, air and water pollution, and depletion of non-renewable energy sources and minerals.

Uher, (1999), suggests that construction activities have a significant impact on the environment across a broad spectrum of off-site, on-site and operational activities. On-site activities relate to the construction or demolition of a physical facility, resulting in the pollution of air, water and land, consumption of resources, traffic problems, waste generation and loss of bio-diversity (Uher, 1999; Shen and Tam, 2002). Off-site activities concern the mining, manufacturing and the transportation of materials and components (Uher, 1999).

### **2.4.1 Effects of the construction industry on the environment**

The construction industry impacts the environment on three main fronts: depletion of natural resources through extraction of environmental resources, such as fossil fuels and minerals; consumption of generic resources, namely, land, water, air, and energy; the pollution of the environment with noise, odours, dust, vibrations, chemical and particulate

emissions, and solid waste; and the production of waste that consumes land for disposal (Shen *et al.*, 2004).

#### **2.4.1.1 Natural Resources**

In the area of raw materials or natural resources, the construction industry accounts directly and indirectly for nearly 40% of the material flow entering the world economy (Roodman *et al.*, 1995). These cover the consumption of renewable and non-renewable resources such as minerals, water and timber for building materials and components. This may also lead to the loss of bio-diversity (Uher, 1999). Not only is the industry a great consumer of raw materials and energy, it is also a great consumer of other resources such as land and water. Cooper and Curwell (1997), estimated that the construction industry in the UK uses as high as 6 tonnes of building materials annually for every member of the population.

#### **2.4.1.2 Pollution**

Existing literature suggests that construction is one of the major contributors to environmental impacts which are typically classified as air pollution, waste pollution, noise pollution and water pollution (Uher, 1999; EPD, 1999 in Shen and Tam, 2002). The pollution of the environment comes from the manufacturing of materials for construction, the transportation, and the use of materials. Though the construction industry consumes energy, majority of this energy use is at the production stage and transportation of materials to construction sites. Energy use on site may represent around 10–15% of the total energy consumption (Edwards *et al.*, 1996 in Shen and Tam, 2002). A by-product of energy consumption is emission of greenhouse gases, particularly carbon di-oxide (CO<sub>2</sub>). Considering off-site and on-site activities of construction, the industry is rated as the most significant emitter of greenhouse gases (Shen and Tam, 2002).

#### **2.4.1.3 Waste Production**

Construction, demolition and excavation (CD&E) constitutes a major source of waste in terms of volume and weight (Kartam *et al.*, 2004). Waste is generated from construction activities such as: excavation; building and civil works; site clearance; demolition activities; road works; and building renovation (EPD, 1998; Shen, *et al.*, 2004; Yuan and



Shen, 2011). Though CD&E waste generation in the UK decreased between 2004 and 2008; from 113.2mt in 2004 to 101.0mt in 2008, this accounts for 35 per cent of total UK waste generation (DEFRA, 2011). These figures however do not include waste from the production of building materials. Production of building materials e.g. cement, ready-mixed concrete, steel, timber, windows, doors, etc., leads to waste of approximately 3–5% of production (Lauritzen, 1994). It is estimated that , approximately 20–50 kg of waste is produced per square metre of constructed flooring, while in demolition waste, this output is estimated to be as high as 1–2 ton/m<sup>2</sup> of flooring (Lauritzen, 1994). The rising amounts of CD&E waste, leads to several issues such as the scarcity of landfill space and the ever-increasing building costs (Kartam, *et al.*, 2004).

According to Levin (1997 in Uher, 1999), the contribution of buildings to the total environmental burden ranges between 12–42% for the eight major environmental stressor categories: use of raw materials (30%), energy (42%), water (25%) and land (12%), and pollution emission such as atmospheric emissions (40%), water effluents (20%), solid waste (25%) and other releases (13%).

#### **2.4.2 Environmental Management and the Construction Industry**

The adverse effects of the construction industry on the environment; soil and ground contamination, water pollution, CD&E waste, noise and vibration, dust, hazardous emissions and odours, demolition of wildlife and natural features and archaeological destruction (Chen and Li, 2006) makes it a critical area of concern in environmental management. There is a need to find alternative materials or techniques that are less environmentally damaging to ensure the negative effects of the industry on the environment as well as raw materials is managed or controlled (Craighill and Powell, 1996). Like the case of environmental management, the shift towards management of the effects of construction on the environment has been supported by academic as well as non-academic concerns.

### 2.4.2.1 History and Development

Impacts of the construction industry on the environment have received major concerns since the early 1970s (Chen and Li, 2006). This led to individual publications on noise pollution (see e.g. U.S.EPA 1971), air pollution (see e.g. Jones, 1973), and solid waste pollution (see e.g. Skoyles and Hussey 1974; Spivey 1974a, b) in construction in the early 1970s (Chen and Li, 2006). These however, could not cause an instant shift towards better management of the environment by the construction industry. Although the expression ‘Environmental Management (EM) in construction’ came out in the early 1970s after the U.S. National Environmental Policy Act of 1969 was enacted (Warren, 1973), it was in the late 1970s that the concept of EM in construction was established. The role of environmental inspector was defined in the design and construction phases of projects to provide advice to construction engineers on all matters in EM (Spivey 1974a, b; Henningson, 1978 in Chen and Li, 2006).

A major shift to environmental management in the construction industry started in the 1990s when two very important standards came into force; the BS 7750 (issued in 1992) and the ISO 14000 series (issued in 1996). These standards were intended to guide the construction industry from passive construction management on pollution reduction to active environmental management systems (EMS) for pollution prevention (Chen and Li, 2006). The standards support the current more forward looking or proactive trend in environmental management and demand longer term management of adaptability, resilience and efforts to reduce the risk of surprises caused by natural disasters (Barrow, 2004, p. 25). During the 1990s, many initiatives were taken both by academic as well as professional bodies and this led to greater awareness of the need to embark on EM in construction.

During the same time, the Construction Industry Research and Information Association (CIRIA) conducted a series of reviews on environmental issues and undertook initiatives relevant to the construction industry after the introduction of BS 7750 (Shorrock *et al.* 1993; CIRIA 1993, 1994a,b, 1995; Guthrie and Mallett 1995; Petts 1996 in Chen and Li,

2006). This led to the increase in research efforts for EM which have also been put into the implementation of EMS and the accreditation of ISO 14001 EMS by authoritative institutions in the construction industry, including the CIOB (Clough and Antonio 1996), the FIDIC (1998), the Construction Policy Steering Committee (CPSC 1998), and the CIRIA (Uren and Griffiths 2000).

Since this time, researchers the world over have focused on the quantitative measurement and effective control approaches to reducing pollution and hazards, such researchers have looked at: life-cycle costing; efficient energy consumption; reduction, re-use, and recycle of CD&E material/debris; degradation and abatement of construction noise and dust; and EIA (Chen and Li, 2006). The implementation of environmental management in construction is known to have a direct contribution to environmental protection (Shen and Tam, 2002). For this reason environmental building performance assessment has emerged as one of the key issues in Sustainable construction (Cole, 1998; Cooper, 1999; Holmes and Hudson, 2000 in Ding, 2008).

### **2.5 THE CONSTRUCTION INDUSTRY AND SUSTAINABLE DEVELOPMENT**

One of the major accusations levelled against the construction industry is the excessive consumption of global resources (Curwell, 1997; Uher, 1999; Ding, 2008) and this puts increasing pressure on the industry to find ways of reducing over reliance on natural resources (raw materials). There are concerns about how to improve construction practices in order to minimise their detrimental effects on the natural environment (Cole, 1999; Holmes and Hudson, 2000 in Bogner, 2007). These concerns have led to the concept of sustainability in construction (Ding, 2008). Sustainable construction management involves the efficient allocation of resources, minimum energy consumption, low embodied energy intensity in building materials, reuse and recycling, and other mechanisms to achieve effective and efficient short- and long-term use of natural resources (Demarco, 2008; Ding, 2008).

In pursuing the mission of sustainable development, efforts towards practicing environmental management in the construction industry have been growing rapidly (Shen and Tam, 2002) embracing all players in the industry. All these efforts notwithstanding it has been difficult to improve the way society uses resources, improve efficiency and reduce the environmental impacts associated with the flow of unwanted materials and energy (Strange, 2002). Though waste generation is a general problem in almost all major industrial sectors, the construction industry is known to be a major producer of waste. The management of waste therefore is a great part of environmental management and sustainability as it can lead to resource conservation as well as solving most of the environmental problems.

## 2.6 THE UK CONSTRUCTION INDUSTRY AND WASTE

In the construction industry however, there is evidence that most of the waste produced actually have residual value and are avoidable (Pinto and Agopyan, 1996 in Teo and Loosemore, 2001). The huge volumes of waste generated during construction and demolition lead to environmental pollution, resource depletion and also an increase in the cost of construction projects. This puts increasing pressure on the construction industry to reduce cost and improve the quality of the environment, and these two goals according to Kartam, *et al.* (2004) can both be achieved through proper CD&E WM

Although it is difficult to determine the exact figures of construction wastes generated on a construction site, data from over thirty years ago estimated that between 10–30% construction materials are wasted (Stone 1983; Fishbein 1998) and waste from the construction industry makes up between 10 and 40% of all waste produced in any developed economy (Lu and Yuan, 2010). Research on WM in the UK suggests that, the construction industry alone contributes about 50% of all wastes produced in the UK in 2012 (DEFRA, 2015). Of the about 200 million tonnes of total waste produced in the UK in 2012, about 100 million tonnes was generated by construction. This makes the industry the highest contributor and in talking about waste and the need for proper environmental management, the construction industry has a very key role to play as the highest single producer of waste in the UK. Figure 4.1 below shows the distribution of waste in the UK in 2012 by all major sectors.

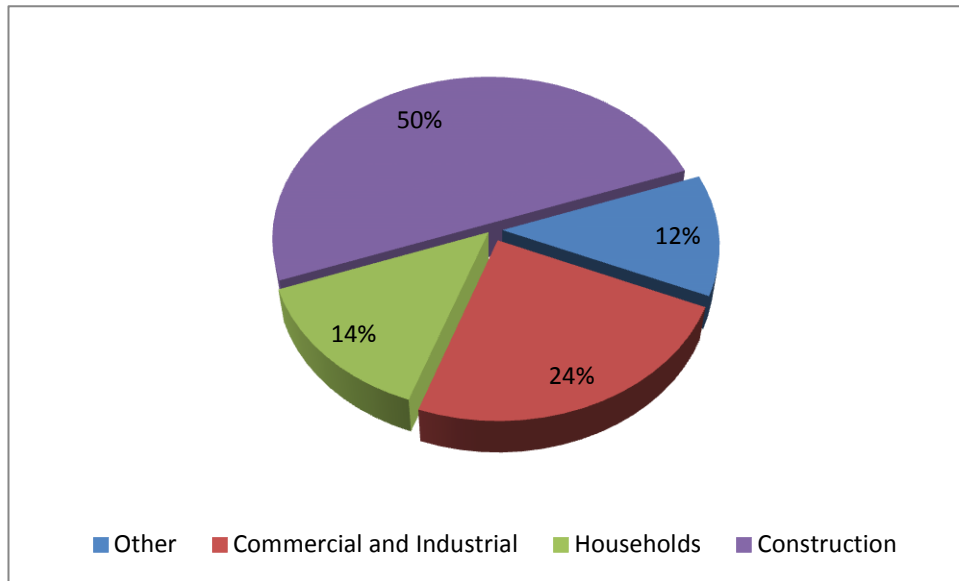


Figure 2. 1: Distribution of waste generation in the UK in 2012

Source: DEFRA (2015)

Comparing the data from 2008 and 2012, it can be concluded that though the total waste generation in the UK has decreased, the contribution of the construction industry to the total waste generation in the UK has increased

### 2.6.1 Construction Demolition and Excavation (CD&E) WM

The management of waste from construction activities has been promoted with the aim of protecting the environment and the recognition that CD&E waste contributes significantly to the polluted environment (Shen *et al.*, 2002). According to the OECD (1998), WM encompasses three main or basic elements (objectives):

- preventing and reducing the generation of waste at source;
- improving the quality of the waste generated (*e.g.* reducing the hazard); and
- encouraging re-use, recycling and recovery.

To achieve these objectives, sustainable WM has been promoted in the construction industry. Sustainable WM in practical terms can be equated to integrated WM which deals with the judicious application of a range of options to achieve a broadly optimal system of

WM and resource recovery (Strange, 2002). The challenge for the construction industry is to re-engineer its entire process in order to significantly reduce its impact on the environment (Uher, 1999). For a WM system to be sustainable, it needs to be environmentally effective, economically affordable and socially acceptable (Nilsson-Djerf and McDougall, 2000; Morrissey and Browne, 2004). Though sustainable WM encompasses the three areas of sustainability, major groups such as project clients, main and subcontractors have concerns for CD&E WM due to the economic benefit and profits with less concern about whether or not the generated CD&E waste would burden the environment (Yuan and Shen, 2011a).

Though the main objective of WM is to reduce the scope for waste to harm the environment or public health (Strange, 2002), proper CD&E WM will not only lead to environmental protection, but will also contribute to sustainable development through: reduction in the amount of raw materials used; reduction in energy consumption; reduction in pollution; reduction in waste produced which will harm the environment; reduced volume of landfill space needed; and reduced transport cost.

Synthesising the issues discussed in this chapter, figure 4.2 below shows the role CD&E WM has to play in the sustainable construction/development agenda. From the negative impacts of the construction industry on the environment as presented in the literature, sustainable CD&E WM is proposed as a means of ensuring the industry does better regarding the use of resources and effects on the environment. The figure shows ways in which CD&E WM can contribute to the sustainable development agenda as proposed by strange (2002). Major ways by which sustainable management of CD&E WM contribute positively to the environment include: resource conservation through the reduction in the amount of raw material use by the industry; the production of secondary materials, cost savings from reduced material purchase and wastage; and reduced pollution which results from CD&E WM contribute to the economic, social and environmental pillars of sustainable development.

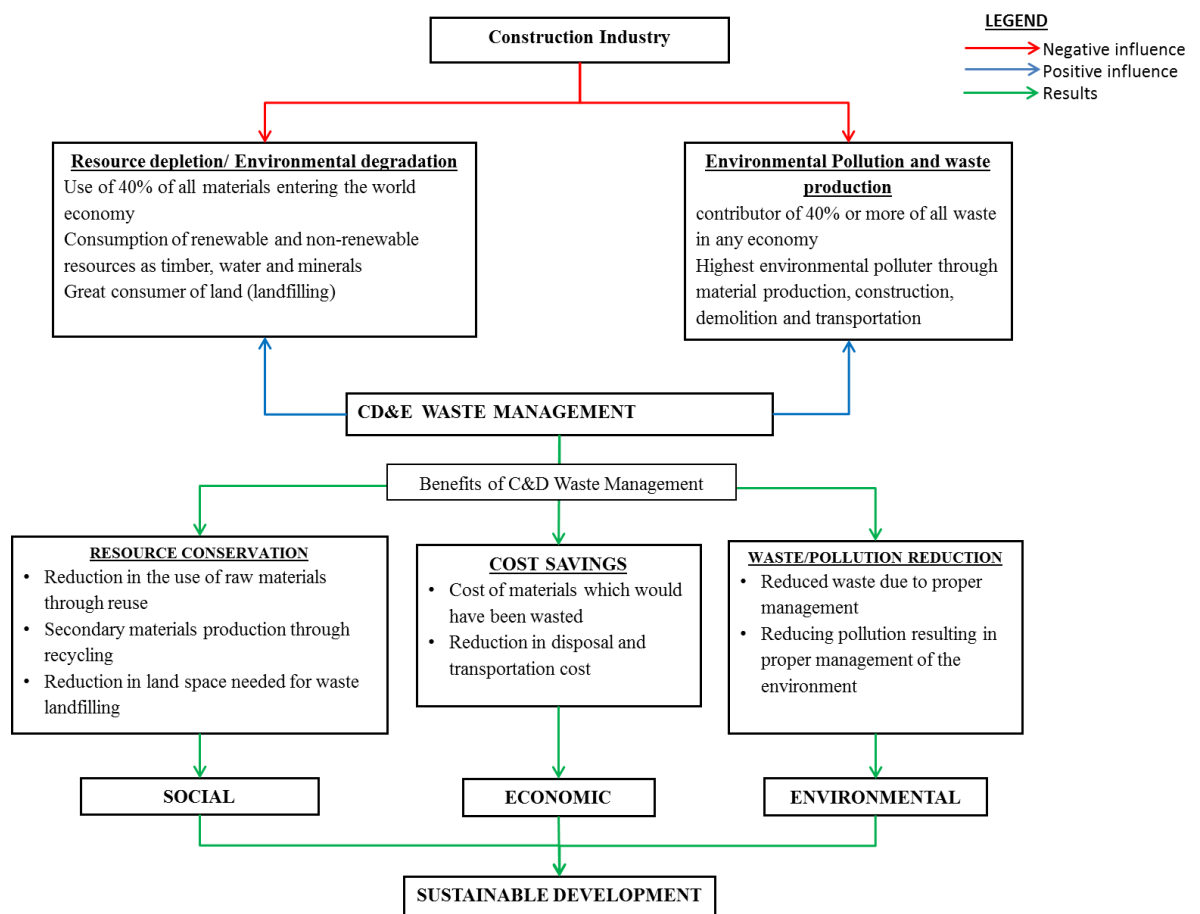


Figure 2. 2 The Contributions of CD&E WM to sustainable development

As shown in figure 2.2 above, the sustainable management of CD&E waste has the potential to positively affect both the social, economic and environmental aspects of sustainability, making it a contributory factor to sustainable development.

The sustainable development paradigm has thus become one of the driving forces in shaping waste policy since the 1980s (Strange, 2002) and has led to WM approaches embracing the three dimensions of sustainability: social; economic; and environment (Strange, 2002). Over the years, the sustainable development paradigm has shaped the area of WM policy through a shift from that of disposal of waste to a more emphasis on resource management and waste prevention, and the management of waste on grounds of economic, social equity, and environmental protection. This has mainly been achieved through the introduction of laws, heightening of awareness of moral obligations, and the economic opportunities from the management of waste.

## **2.7 CHAPTER SUMMARY**

This chapter has reviewed literature on the development of environmental management as well as the sustainable development concept. The origins of these concepts have been traced to determine the main driving forces leading to the current demands the concepts place on industry. As shown in the chapter, the construction industry is a very important industry to these concepts due to the effects of construction activities on the environment and sustainable development as a whole. The chapter has also identified the role of the construction industry and more especially CD&E WM in contributing to sustainable development.

As shown in the last section of the chapter, the sustainable development concept has been the main driving force behind WM and as such has influenced WM legislation and policy. The next chapter reviews the history and development of government WM legislation and policy to determine the demands it places on the management of CD&E WM in the UK.



## CHAPTER THREE

### REGULATORY ENVIRONMENT FOR WASTE MANAGEMENT

#### 3.1 INTRODUCTION

According to European Union guidelines, the reduction of the levels of waste generation and the increase in energy and material recovery represent two of the most important future requirements for environmentally-sound WM practices (Marchettini *et al.*, 2006). In order to preserve the environment and guarantee growth, a great number of environmental regulations and initiatives have been developed most of which seek to minimize and control construction and demolition waste (Solís-Guzmán, *et al.*, 2009). Literature on CD&E WM suggests that regulations have a vital role to play in ensuring sustainable WM is achieved. This chapter reviews literature on waste legislation and analyzes waste legislation in the European Union (EU) and the UK and how waste regulations fall in line with the overall agenda of sustainable WM.

#### 3.2 REGULATION AS A DRIVER OF WASTE MANAGEMENT

Osmani, Glass and Price (2008) summarise the key drivers for waste reduction in construction into four broad categories which are environmental, industry and economic concerns in addition to government policies and regulations. Wang, *et al.*, 2010 identified Seven factors as the Critical Success Factors (CSFs) for managing CD&E waste: (1) WM regulations, (2) WM system (WMS), (3) awareness of CD&E WM, (4) low-waste building technologies, (5) fewer design changes, (6) research and development in WM, and (7) vocational training in WM. This is in line with (Jaillon and Poon, 2008) and (Karavezyris, 2007) who suggested that government generally plays a crucial role in promoting CD&E WM practice by enforcing policies for the whole industry. The role of legislation/regulation in WM therefore cannot be over emphasized.

##### 3.2.1 Defining waste in the regulatory environment

In looking at the regulatory aspects of waste, it is important in the first place to define what waste is according to the regulations. Definition is very important in law and particularly

important in a system of regulatory control as it is necessary to define what can and cannot be controlled (Cheyne and Purdue, 1995). According to Abbot (2000), for the purpose of regulation, regulated objects need to be clearly and flexibly defined to avoid placing excessive costs both on the regulated and the regulators in the course of achieving its objective. Ideally, the legal definition of waste should be sufficiently wide to encompass all the activities that need to be controlled but not so wide that it results in over-regulation (Cheyne and Purdue, 1995). Though no one approach to definition can usually lead to the fulfilment of all these requirements, a look at some of the definitions used for the purposes of regulation indicates that there is a central theme which surrounds words such as discard, dispose and abandon.

There is no clear cut definition as to what may or may not be waste. The Royal Commission on Environmental Pollution made the first attempt at a statutory definition of 'waste' in English law in the Deposit of Poisonous Waste Act 1972 which defined it as the deposit of substances in circumstances where the person depositing it could 'reasonably be assumed to have abandoned it or that it was being disposed of as waste'. The EU Directive on waste, 75/442/EEC defines waste as 'any substance or object in the categories set out in Annex I which the holder discards or intends or is required to discard'. The Environmental Protection Act **1991** defines waste as;

- (a) Any substance or article which constitutes a scrap material or any effluent or other *unwanted* surplus substance arising from the application of any process; and
- (b) Any substance or article which requires to be *disposed* of as being broken worn out, contaminated or otherwise spoiled.

From the various definitions of waste, the overriding concern is the state in which the owner or holder of the material leaves it. Serpell and Alarcón, (1998) define waste as any material by-product of human and industrial activity that has no residual value. The literature on CD&E waste however, has evidence to suggest that most CD&E waste have residual value and are avoidable (Pinto and Agopyan, 1996 in Teo and Loosemore, 2001). For the purposes of construction and demolition, waste can therefore be regarded as any

product or material arising out of construction or demolition activities which the producer discards, intends to or is regarded to discard.

### 3.2.2 Concerns of Regulation

Regulation over the past decades has been a topic that has stimulated discussion in a host of disciplines - law, economics, management, social administration etc and this makes regulation a field of study that calls for multi-disciplinary approach (Baldwin, Cave and Lodge, 2011). In the area of CD&E WM, this has been an area of concern for most WM researchers as well as practitioners. It has attracted supporters and opponents alike. Whereas Supporters see regulation as a technocratic device that has the potential to exert rational controls over important economic and social activities, sceptics regard regulation as a little other than 'red tape' and a potential burden on economic activity (Baldwin, Cave and Lodge , 2011). According to sceptics, environmental Legislation may place major burdens on industry and business (Fergusson and Langford, 2006). For supporters however, the development of environmental policies in order to reduce costs of CD&E WM has proved to be beneficial (del Río Merino, Gracia and Azevedo , 2010).

### 3.2.2 Definition of Regulation

The core understanding that many have of 'regulation' is some form of 'command and control' (CAC) regulation: regulation by the state through the use of legal rules backed by (often criminal) sanctions (Black, 2002). This understanding according to Black (2002) has also become shorthand to denote all that can be bad about regulation, including poorly targeted rules, rigidity, ossification, under- or over- enforcement, and unintended consequences. Various definitions have been given to the concept of regulation by authors;

Selznick (1985) speaks of regulation as a sustained and focused control exercised by a public agency over activities that are valued by a community (the central meaning of regulation). Baldwin, Scott, and Hood in their book on regulation identify three definitions; in the first instance, regulation is the promulgation of rules by government accompanied by mechanisms for monitoring and enforcement, usually assumed to be performed through a

specialist public agency. The second definition sees it as any form of direct state intervention in the economy (regardless of the form of intervention). In the third definition, regulation is all mechanisms of social control or influence affecting all aspects of behaviour from whatever source, whether they are intentional or not (Baldwin, Scott, and Hood, 1998 in Black, 2002) .

The Organisation for Economic Co-operation and Development (OECD, 1997) defines regulation as 'the full range of legal instruments by which governing institutions, at all levels of government, impose obligations or constraints on private sector behaviour. The legal instruments may be in the form of constitutions, parliamentary laws, subordinate legislation, decrees, orders, norms, licences, plans, codes and even some forms of administrative guidance. UK government's Better Regulation Taskforce (BRT) defines regulation as 'any government measure or intervention that seeks to change the behaviour of individuals or groups (Black, 2002). Black (2002) after reviewing literature on regulation defines regulation as 'the sustained and focused attempt to alter the behaviour of others according to defined standards or purposes with the intention of producing a broadly identified outcome or outcomes, which may involve mechanisms of standard-setting, information gathering and behaviour modification.

In all the definitions of regulation, the central point remains as a means to affect/control the activities/behaviour of people for a specific outcome. As noted in Baldwin, Cave and Lodge (2011), though the concept of regulation is often thought of as an activity that restricts behaviour and prevents the occurrence of certain undesirable activities (a red light concept) the broader view is however that, the influence of regulation may also be enabling or facilitative (green light).

### **3.2.3 Regulations in waste management (environmental protection)**

According to Fergusson and Langford (2006), concern for the environment usually becomes a political issue and leads to the making of legislation. Legislation sets the rules and standards that tell people and industry how to behave leading to the setup of public

agencies to make sure behaviour is in line with what has been politically defined as preferable (Nielsen, 2006).

The first systematic attempts to control the polluting effects of the industrial revolution in the UK were made by the Alkali Acts in the 19th Century. Later legislation addressed pollution of water and land (Deposit of Poisonous Wastes Act 1972). Since the UK joined the European Union (EU) in 1972, the process of making these domestic regulations has gradually/increasingly changed and has been shaped by the EU laws. Waste legislation within the UK is now derived from the European regulatory framework through the process of Europeanization. Radaelli, (2003 in Burma and Burch, 2005) defines Europeanization as: Processes of (a) construction, (b) diffusion and (c) institutionalization of formal and informal rules, procedures, policy paradigms, styles, 'ways of doing things' and shared beliefs and norms which are first defined and consolidated in the EU policy process and then incorporated in the logic of domestic discourse, identities, political structures and public policies. To have a wider understanding of UK WM legislation, it is necessary then to trace them from the EU WM Legislation.

### **3.3 MANAGEMENT OF WASTE IN THE EUROPEAN UNION**

Though environmental protection was not part of the 1957 treaty of Rome (founding treaty of the EU) (Clinch, 2000; Jordan, 2006), policies on the protection of the environment and natural resources have increased over the years and the EU has grown into an environmental power house where the environment is given a high priority. Whereas in 1973 the EU saw the environment as being wholly subsidiary to the functional requirements of creating and sustaining a single market in goods and services, environmental protection is now widely regarded as an objective worth fighting for in its own right (Jordan, 2006). The history of this development shows that since EU national leaders signed the Single European Act in 1985, the EU's legal commitment to achieving environmental protection has increased and this has been further strengthened by the Maastricht and Amsterdam Treaty amendments (Clinch, 2000; Jordan, 2006).

By Europeanization, national legislative processes in the EU are now predominantly influenced by the EU-legislation due to the objective of the EU that all member states should ultimately reach the same standard in WM. Responsibility for WM in the EU falls into two broad areas: the legislative area, which covers all applicable laws and ordinances on how to avoid, recycle, transport, treat and dispose the different kind of wastes, and the executive area, which is made up of the institutions which are responsible for enforcing the legislation (Nowak, Steiner and Wiegel, 2009).

The executive branch of the EU comprises three distinct institutions which are; the European Council, the Council and the European Commission. The European council brings together heads of state and government, along with the president of the European Commission, with the aim to provide the impetus for the development of the Union and to issue general policy guidelines. The council consists of ministers of each EU member state and meets regularly in different configurations depending on the subject matter; it carries out policy-making and coordinating functions. **The European Commission** is headed by a College of Commissioners comprised of 27 members, one from each member country; each commissioner is responsible for one or more policy areas. The legislative area is represented by the national parliaments which create the laws regulating the handling and management of waste.

There are two different types of legislation set by the EU; EU-Treaties/Ordinance known as primary legislation that forms the basis for the union which sets out the aims, objectives and obligations and has immediate effect in all member states without any conversion or changes by the different nations. The second form of legislation is the secondary legislation which according to article 249 of the treaty of Rome (EC Treaty) can be divided into three main groups; EU-Regulation which apply directly to the laws of member countries, EU-Directive, which sets binding required results but gives room to be transferred into national law of the member states and EU-Decisions which is also binding in its entirety unto particular member countries to which it applies. Though binding, EU Directives are not directly applicable and provide member states with some flexibility to comply with framework conditions (Clinch, 2000).

### 3.3.1 European Union Waste Legislation

The European Union (EU) has adopted a number of Directives aimed at harmonizing WM and disposal policies throughout Europe to guarantee the protection of public health as well as the environment (Pongrácz and Pohjola, 2004). The major legislative drivers include the Landfill Directive, the Integrated Pollution Prevention and Control (IPPC) Directive and the Waste Framework Directives together with waste stream specific directives such as end-of-life vehicles (ELVs), packaging and waste electrical and electronic equipment (WEEE) Directives, the Mining Waste Directive, etc. Though there are many directives or legislation regarding waste in the EU, this review is limited to Directives that directly affect construction and demolition WM.

Relevant directives affecting CD&E WM are the Landfill Directive, the IPPC and the Waste Framework directive, the most prominent of which is the Waste Framework Directive.

#### 3.3.1.1 History of Development of EU waste directives

The development of EU laws/directives on waste has closely followed the development of environmental management as well as sustainable development concerns.

The first directive which required Member States to make a WM plan was laid down in the Council Directive 75/442/EEC of 15 July 1975 on waste (DIRECTIVE 75/442/EEC; Clinch, 2000) and sets the basis for EC WM policy (Thieffry and Nahmias, 1991). This legislation applies to any substance or object which the holder discards or intends to or is required to discard (all types of waste). The main aims of this regulation were first to prevent or reduce waste generation and its harmfulness, and secondly to recover waste by means of recycling, re-use or reclamation or any other means with the extraction of secondary raw materials, or to use waste for energy generation. This required Member States to take the necessary measures to ensure that waste is recovered or disposed of without endangering human health and without using processes or methods which could harm the environment.

The 1975 Waste Directive was followed in 1978 by the Directive on Toxic and Dangerous Waste, which applied to "any waste containing or contaminated by the substances or materials in such quantities, or in such concentrations as to constitute a risk to health or the environment. Along with the development of environmental concerns, waste was increasingly an issue in the 1980s and EU environmental policy making increased during the same time with campaigns from Germany and other states for stringent protection measures. This caused the EU to expand the scope of its environmental activities further beyond its economic origins. In 1991, the EC introduced the Council Directive 91/156/EEC which amended the 1975 waste directive and portions of the 1978 directive on toxic or hazardous waste.

Since the 1992 United Nations 'Earth summit' in Rio de Janeiro, EU environmental policy has emerged as one of the best known and most rapidly developing areas of EU activity (Jordan, 2005). In 1992 the European Commission proclaimed demolition and construction waste as a priority waste stream (TrnklerIsa and Dohmann, 1996). In 1996, the Commission Decision 96/350/EC adapted annexes (IIA and IIB) to the 1975 waste directive which listed recovery and disposal operations for the management of waste. In the 1999 Amsterdam Treaty and the 2001 Gothenburg summit in Sweden, EU leaders recognised the environment as a policy area of equal political importance to the economic and social sectors (Jordan, 2006). The Landfill Directive (99/31/EC) was passed in 1999 which aimed at reducing the amount of waste going to landfill and further set a target to reduce the total weights of biodegradable waste produced in 1995 to 35% by the year 2016 (Directive, 1999).

### **3.3.1.2 Current EU Waste Directives**

Driven by global environmental problems and the depletion of natural resources, the major focus of WM policies changed during the late twentieth and early twenty-first centuries. This reflects in EU strategies on WM and has contributed to the EU framework on WM. Though the waste directive has always favoured reduction and reuse of waste, formerly the focus of EU waste strategies was on promoting environmentally sound waste treatment and



disposal to avoid local environmental pollution. There has been a shift over the years to pursue the concept of sustainability. This has been done through the introduction and promotion of the EU waste hierarchy which promotes the concept of the 3Rs of WM; Reduce, Reuse and Recycle (Sakai, *et al.*, 2011). After the commitments made at the Earth Summit in Rio de Janeiro (1992), the European Council in 2001 adopted the first EU Sustainable Development Strategy (SDS) (Ledoux, Mertens and Wolff, 2005) with an overall aim of promoting and supporting actions that will ensure the achievement of improved quality of life for both current and future generations (Pires, Martinho and Chang, 2011a).

In Decision (EC) 1600/2002 laying down the sixth environmental action programme, the European Parliament established sustainable use and management of natural resources and waste as priority areas for action (Nash, 2009). This is expected to be achieved through the creation of sustainable communities capable of managing resources efficiently, tapping the innovation potential of the economy, ensuring prosperity, environmental protection and social cohesion (Pires, Martinho and Chang, 2011). Scarcity of resources has motivated new strategies at European level to promote life cycle thinking in WM policies tying it down with how to integrate economically feasible and environmentally sustainable practices holistically. In proposing a revision to the WFD in 2003, the European Commission intended to reduce the use of natural resources through the practical application of the waste hierarchy. This is to promote the management of resources by introducing measures to address waste prevention and to focus on reducing the environmental impacts of waste generation and management by encouraging life cycle thinking (Nash, 2009). Current directives affecting CD&E WM in the EU include the Landfill Directive (Directive 1999/31/EC), the Waste Framework Directive (2006/12/EC) and the Integrated Pollution Prevention and Control Directive

### **3.3.1.3 The Landfill Directive (Directive 1999/31/EC on the landfill of waste)**

The Landfill Directive ([Directive 1999/31/EC](#) on the landfill of waste) supplements the requirements of the Waste Directive by specifying uniform technical standards at Community level and setting out requirements for the location, management, engineering,

closure and monitoring for landfills. The Directive also includes requirements relating to the characteristics of the waste to be landfilled; these are supplemented by [Council Decision 03/33/EC](#), which establishes criteria and procedures for the acceptance of waste at landfills. The Landfill Directive is seen to be the best of EU legislation in promoting waste reduction among the various waste producing industries.

### **3.3.1.4 The Waste Framework Directive (Directive 2006/12/EC on waste)**

The EU thematic strategy on the prevention and recycling of waste released in 2005 formulated a vision of “the EU as a recycling society” (EU, 2005). Though this was regarded a very ambitious vision (Fischer , 2011), it represents a good option to ensure more sustainable society with less use of virgin materials, less use of energy, and fewer greenhouse gas (GHG) emissions as well as less polluting emissions to soil, water, and air. The Waste Framework Directive (WFD; [Directive 2006/12/EC on waste](#)) which followed contains the [definition of waste](#). This definition is used to establish whether a material is a waste or not but a bi-product of a production process. An important objective of the WFD is to ensure the recovery of waste or its disposal without endangering human health and the environment.

Great emphasis is also placed on the prevention, reduction, re-use and recycling of waste. It provides the framework and sets goals for WM in EU member states. The directive requires the competent authority in each member state to draw up WM plans to ensure:

- By 2012 50% reduction in the total annual quantity of waste generated to 2008 levels
- By 2020 50% of municipal waste and 70% of the construction and demolition waste has to be recycled
- By 2015 systems for separate collection must be established.

The current Waste Framework Directive, Waste Directive 2008/98/EC (EU Commission, 2008), reflects EU SDS and brings new challenges to sustainable WM systems (Pires, Martinho and Chang, 2011b). Directive 2008/98/EC involves a wealth of WM practices

tied to policies, institutional settings, financial mechanisms, technology selection, and stakeholder participation (Pires, Martinho and Chang, 2011).

Waste Directive 2008/98/EC introduces the "polluter pays principle" and the "extended producer responsibility". It incorporates provisions on hazardous waste and waste oils and includes two new recycling and recovery targets to be achieved by 2020: 50% preparing for re-use and recycling of certain waste materials from households and other origins similar to households, and 70% preparing for re-use, recycling and other recovery of construction and demolition waste.

### **3.3.1.4 The Integrated Pollution Prevention and Control Directive (Directive 2008/1/EC)**

The IPPC Directive ([Directive 2008/1/EC](#)) aims to minimise pollution to air, water and soil from various industrial sources throughout the European Union. Operators of industrial and waste installations covered by Annex I of the IPPC Directive are required to obtain an authorisation (environmental permit) from the authorities in the EU countries. The regulators set permit conditions to achieve a high level of protection for the environment. The conditions are based on Best Available Techniques, which take into account costs to the operators and benefits to the environment. Installations covered by the IPPC Directive and dealing with waste include non-inert landfills, waste incineration facilities and plants processing (crushing) construction and demolition waste.

## **3.4 EUROPEANIZATION OF UK NATIONAL LAWS**

### **3.4.1 History of UK Waste Legislation before the EU**

The UK established the world's first environment ministry in 1970 and was one of the very first countries in the world to develop a comprehensive suite of national environmental laws (Jordan, 2006). Even before the coming into force of the EU Directives on landfill (1999/31/EC), the operations of landfills in the UK were subject to either the WM Licensing Regulations 1994 or the Pollution Prevention and Control (England and Wales)

Regulations 2000 (Statutory Instrument 2000 No.1559). Coming from this background, it felt confident about the way in which it addressed its environmental problems and saw very little or no role for the EU (Porter, 1998; Jordan, 2006). Ministers and civil servants assumed that when common policies were adopted in Brussels they would have no impact on Britain, because British policies were intrinsically superior to anything that the EU could deliver (Jordan, 1998; Lowe and Ward, 1998). Although Britain did have comparatively advanced nature conservation policies, its pollution control policies in the 1970s lagged well behind those of the environmental ‘lead’ states of the EU.

When the UK joined the EU in 1972, provision was made for the application of EU laws through the European Communities Act (1972) and this gave existing and future EU Acts direct effect over domestic laws and constitutional provisions (Jordan, 2006). At the early stages however, the UK did not regard EU common policies as superior to Local policies (Jordan, 1998; Lowe and Ward, 1998; Porter, 1998). This feeling of quite self-satisfaction and unwillingness to give up National legislation for EU legislation caused UK to trail badly both nationally and internationally on environmental matters by the late 1980s (Porter, 1998) and was poorly ranked among EU member states in recycling (Johnson, Leicester and Levell, 2010). While the rest of the EU were forging ahead with recycling and composting some years back, the UK mainly relied on Landfills. The UK as at 1990 landfilled 90% of its waste (Buclet and Godard, 2001). This robbed it of the huge economic benefits that flow from higher environmental standards and denied the British public of an opportunity to enjoy the same high standards that existed in other countries (Jordan, 2006).

### **3.4.2 UK National Laws Transposing EU Directives**

The ratification of the Single European Act (1986) the treaty of Maastricht (1992) and the treaty of Amsterdam (1997) further ensured that EU laws have supremacy over all domestic laws in the member states of the EU. Since this time, ‘Europeanization’ of the UK has occurred (Jordan, Wurzel and Zito, 2003; Burma and Burch, 2005). In 2006, almost all of the most important national environmental policy decisions of Britain were taken on the basis of negotiation within the institutions of the EU. The EU now accounts

for between 80 and 90% of new national legislation (Jordan, 2006). Various studies show that the British public place more trust in the EU to protect Britain's environment than the British government, British politicians or British industry and environmental issues are seen as the third most important political priority for EU attention after securing international peace, and tackling crime and drugs (Jordan, 2006). Unlike some other policy areas, all the mainstream political parties in Britain broadly accept that the environment is rightfully a matter for EU-level action and Parliament devotes a great deal of its time to scrutinizing new EU laws

Waste legislation within the UK is now derived from the European regulatory framework. The UK parliaments have a number of acts which form the basis for the development of regulation to implement EU directives on waste and there are a number of regulations relating to the management, transport, treatment and disposal of waste in the UK which implements the various EU Directives. The EU laws have been transposed into UK National laws by regulations in the UK which have been repealed or amended over time to reflect the changes in the EU laws. As the focus of EU WM laws change, so do that of the UK.

The WFD has largely been implemented in the UK through the Environmental Protection Act 1990 (as amended), through the Duty of Care (1990) and WM Licensing (1994) regulations. The Act provides the basis for licensing controls and other provisions aimed at ensuring that waste handling, disposal and recovery options do not harm the environment. It also states that responsibility for waste rests on all parties involved in its management; from the original producer to everybody who handles it up until its full recovery or disposal.

Most of the regulations dealing with the management of waste in the UK have been repealed or amended by the Environmental Permitting (England and Wales) Regulations 2010 which is now amended by the Environmental permitting (England and Wales) Amendment Regulation 2012. The amendment regulation which aims to protect the

environment while simplifying the regulatory system for complying with EU Directives on waste introduces a new permitting regime for waste and identifies a number of activities which are exempt from permitting. Schedule 9 of The Environmental Permitting Amendment Regulations now implements the Waste Framework Directive and the IPPC Directive. [Schedule 10](#) of the Environmental Permitting (England and Wales) Amendment Regulations (EPR) 2012 now transposes and implements the Landfill Directive and Council Decision 2003/33/EC which aims to prevent, or to reduce as far as possible, the negative environmental effects of landfill.

The waste hierarchy requirement has been transposed in England and Wales by Regulation 12 of the Waste (England and Wales) Regulations 2011. The effect of the regulation is to impose a duty on waste producers (other than households) to take all reasonable measures to apply the waste hierarchy so as to prevent material becoming waste (e.g., by reusing or extending the life of products). If it is not feasible to prevent the material from becoming waste then the listed WM options must be applied in descending priority order (waste hierarchy). The duty to apply the waste hierarchy is enforceable by the Environmental Agency (EA) by means of a compliance or stop notice. A breach of either is a criminal offence carrying a fine of up to £5,000 on conviction in a magistrates' court and an unlimited fine on conviction in the Crown Court.

The Waste (England and Wales) (Amendment) Regulations 2012 is to enforce separate collection of waste where “necessary” to ensure that waste undergoes recovery operations in accordance with the Directive and to facilitate or improve recovery where it is “technically, environmentally and economically practicable” (Defra, 2012a). The duties apply to household waste as well as commercial or industrial waste. The Amended regulation from 1<sup>st</sup> January 2015 requires separate collection of waste paper, metal, plastic and glass.

The UK has a specific legislation for managing CD&E waste. Exercising powers in the Clean Neighbourhood Act (2005), the English parliament in 2008 came up with the site WM plans Regulations (SWMP) 2008. This regulation forms the basis for the legal

requirement for the management of CD&E waste. The SWMP (2008) requires all clients with single construction or demolition projects having a value (without vat) of £300,000 or more to prepare a plan showing the expected levels of waste and how the waste expected from the activity will be managed. This regulation also requires construction firms to employ the waste hierarchy in the management of waste from construction activities to ensure the best is made from the waste the industry produces and also to ensure that waste is transferred only to registered carriers by contractors.

### **3.4.3 Regulatory Framework for CD&E WM in the UK**

A general overview of the legal framework for the management of waste in the UK construction industry is shown in Figure 3.1 below. Though there are many other regulations on waste in the UK, the framework covers only the regulations that have a direct impact on the management of waste in the construction industry (CD&E waste). Figure 3.1 shows the various EU directives and as well as the Acts of the UK parliaments that form the basis to transpose the directives into national law. As shown on the figure, as a way of simplifying and unifying most of the WM regulations, different portions of the regulations have been amended by the Environmental Permitting (England and Wales) Regulations 2012 and the Waste (England and Wales) Regulations 2012.

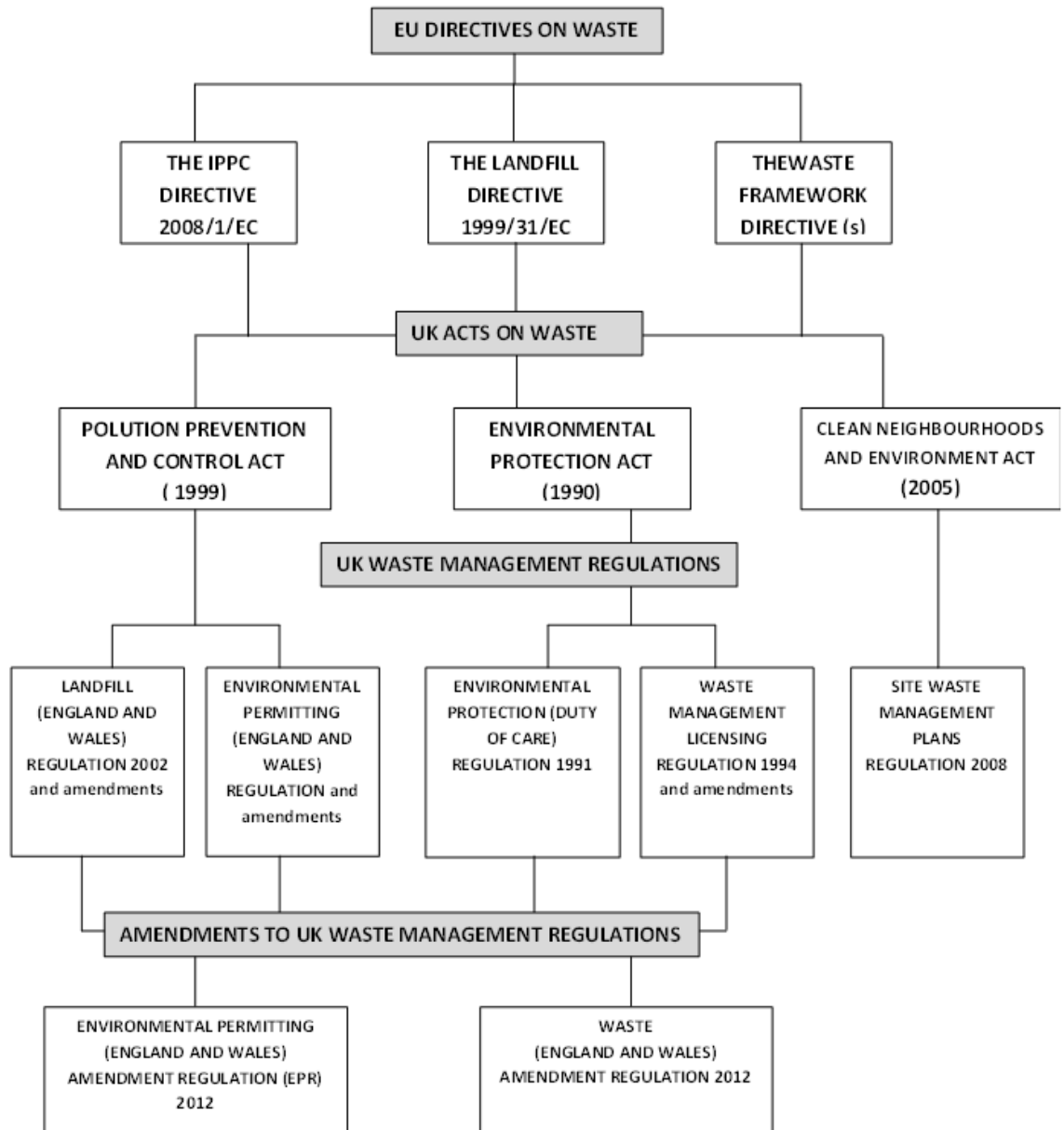


Figure 3. 1: UK legal framework for CD&E WM

### 3.5 ACHIEVING SUSTAINABLE WM IN THE EU/UK



To achieve the aims of the EU legal framework on WM, the EU employs principles which guide the making of WM legislation. Key among these are the EU WM principles and the use of the waste hierarchy (WH) which are discussed below.

### 3.5.1 EU WM Principles

Principles behind EU WM efforts are established by the EU Waste Framework Directives and the EU Strategy for WM (Thieffry and Nahmias, 1991; Clinch, 2000; Strange, 2002; European Commission, 2003). Four principles are employed by the EU in the fight for sustainable WM within the region include: the Prevention principle, the Precautionary principle, Principles of the polluter pays and producer responsibility, and Principle of proximity and self-sufficiency. The Prevention principle advocates for nature and resource conservation through processes aimed at minimization the generation of waste and avoidance where possible. The Precautionary principle calls for all necessary precaution/action to ensure a reduction in the impacts of waste on human health and the environment. The approach of the Principles of the polluter pays and producer responsibility is to ensure that those who generate waste or contaminate the environment pay the full costs of their actions. This includes all the costs necessary for managing the effects of the waste generated on the environment as well human health. As part of WM efforts, this principle is to ensure adequate infrastructure for WM is provided by establishing an integrated and adequate network of disposal facilities.

### 3.5.2 The Waste Hierarchy

The EU promotes WM through the use of the waste hierarchy and demands waste producers to take every effort to manage the waste being produced by the use of the hierarchy. Article 4 of the Waste Directive ([Directive 2008/98/EC](#)) has defined waste hierarchy as a general overall priority order for the options that deliver the best overall environmental outcome in waste legislation and policy. The primary principles of the hierarchy are minimizing resource consumption and preventing environmental pollution which are said to be the two pillars of sustainability in construction (Peng *et al.*, 1997; Strange, 2002). Figure 3.2 below shows the waste hierarchy as used in the EU for ensuring sustainable WM.

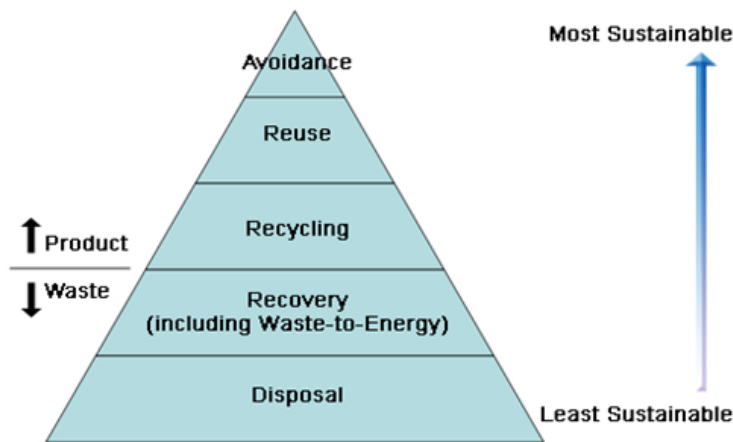


Figure 3. 2: Hierarchy in the EU Directive 2008/98/EC

(Adapted after zunft und fröhlig 2009)

As shown in figure 3.2 the waste hierarchy promotes in the preferred order the WM practices from lowest to highest environmental impact.

Prevention is the most preferred option in WM and sits at the top of the hierarchy. This is because it is the option that has the least effect on the environment. Under waste prevention or avoidance, the aim is to prevent the material from becoming waste by managing its use. Waste reuse is the second option and requires waste produces to reuse the waste as much as possible for other activities to prevent the negative effects of the waste on the environment. This option includes the preparation of the material for reuse and can even mean cleaning materials (waste) so they can be reused. Reuse of material can be for the same purpose as material was used before or for different purposes. They key element of material reuse is that the material does not undergo any processing before its second use. Recycling applies to the processing of the material (waste) so it can be used as new or secondary material which can replace the use of natural resources (raw materials). This WM option is intended to help reduce the ability for waste to harm the environment as well as the over reliance on natural resources. Other recovery as used in the hierarchy refers to any other option for recovering value from the waste which cannot be recycled and includes activities such as energy recovery. Disposal is the least preferred WM option and waste that could not be prevented, reused or recycled are required to be properly disposed normally through landfilling.

Though the hierarchy defines the stages expected in the managing of waste, the overarching objective is to use the best available method to achieve the best out of the waste. This is expected to achieve the best overall environmental outcome. Though landfilling, is ranked lowest in the waste hierarchy due to the lack of utilisation of the resources in the waste it remains the most common waste treatment method in the European Union (European Commission, 2003).

According to Wilson (1996), a systematic shift in WM away from disposal and towards waste prevention and recycling requires the use of an integrated set of policy measures to change the behaviour of waste generators; industry, commerce and consumer.

To ensure WM is moved up the waste hierarchy, the Waste Framework Directive (2008/98/EC) requires Member States to adopt WM plans and [waste prevention programmes](#). Member states are expected to set up waste prevention programmes which will target the prevention of waste by putting it into WM plans or other legislation by 12 December 2013. These programs, also known as National waste prevention programmes are to establish plans which shall be integrated either into the WM plans or into other environmental policy programmes, or function as separate programmes.

With the aim to break the link between economic growth and the environmental impacts associated with the generation of waste the programmes shall set out the waste prevention objectives with clearly identified waste prevention measures. According to Article 29(3), Member States shall determine appropriate specific qualitative or quantitative benchmarks for waste prevention measures adopted, in order to monitor and assess their progress. Article 29(5) also obliges the Commission to create a system for sharing information on best practice regarding waste prevention and develop guidelines in order to assist the Member States in the preparation of the programmes (EU Commission, 2008). To promote and encourage the recycling of materials within the member countries, the Waste Framework Directive (2008/98/EC) has introduced criteria for the branding of materials as 'non waste' and introduces the possibility that waste can cease to be waste.

### 3.5.3 Enforcement of WM Legislation in the UK

Like the Executive branch of the EU, all member states have agencies and departments which are in charge of ensuring waste legislation is enforced at the local and regional levels. Once a Directive of the EU is transposed into national laws, national agencies are put in charge to oversee its implementation by the regulated entities. The mode of enforcement is also determined by the particular regulation. Systems for the protection of the environment which oversee the enforcement of WM legislation in the UK are;

- The Environment Agency (which covers England and Wales)
- The Scottish Environmental Protection Agency
- The Department of the Environment in Northern Ireland and
- Local authorities

### 3.5.4 Compliance with WM Legislation

WM regulations are considered as one of the critical success factors (CSFs) for the management of construction and demolition waste (Osmani *et al.*, 2008; Lu and Yuan, 2010). The mode of enforcement of regulations as well as the level of compliance goes a long way to affect the results as the attitudes and behaviours of regulated firms are crucial in solving the problem of WM (Begum *et al.*, 2009). According to (Gunningham, Thornton and Kagan, 2005) most regulatory policymakers and officials (at least in the United States), believe that strong legal punishment of serious and wilful violations serves a vital "general deterrence" function. This view stems from the assumption that regulated firms are "amoral calculators" (Kagan and Scholz, 1984) that take costly measures to meet public policy goals only when (1) specifically required to do so by law, and (2) they believe that legal noncompliance is likely to be detected and harshly penalized (Becker, 1968; Miller & Anderson, 1986). However, Simpson (1990) shows that regulated firms' perceptions of legal risk play a far more important role in shaping firm behaviour than the objective likelihood of legal sanctions. Though there is no single means of ensuring compliance with environmental or WM legislation/regulations, it is suggested that enforcement styles that includes economic incentives are very likely to achieve higher results.

### **3.6 CHAPTER SUMMARY**

This chapter has reviewed the regulatory framework for waste management in the UK with emphasis on CD&E WM in England and Wales. From the review, it was evident that waste management legislation in the UK is determined by the EU waste framework Directive which seeks to ensure the sustainable management of waste from industries. In the UK, EU waste legislation has been transposed by different regulations which seek to ensure that waste management is given the needed consideration. For CD&E waste management, current legislation requires the pursuit of sustainable waste management with the intended outcomes being: reduction in the amount of waste produced; reduction in the level of pollution from CD&E waste; reduction in the amount of space needed for waste landfilling; and economic management of waste.

## CHAPTER FOUR

### CONSTRUCTION, DEMOLITION AND EXCAVATION WASTE MANAGEMENT

#### 4.1 INTRODUCTION

The recognition of the negative effects of the construction industry on the environment (through the production of waste) and the associated effects waste on the cost of construction projects has received recognition from both academia and industry. This has over the years led to the proliferation of research studies on the management of waste in the construction industry (Lu and Yuan, 2010). A review of the trend in literature on the subject shows that, CD&E WM studies did not have much recognition some 10 years back as it does today. The interest in the subject is as a result of a gradual shift in the attention of the world from just development towards development management which covers the management of the environment (Barrow 2004, p8). This chapter reviews relevant literature covering the boundary of CD&E WM and analyzes the themes, trend, and types of studies and methods of analysis used. It also looks at the future direction for research in the area and identifies gaps the current research seeks to fill.

#### 4.2 BOUNDARY OF CD&E WASTE MANAGEMENT RESEARCH

CD&E waste has been receiving increasing attention from industry practitioners and researchers since the early 1980s. Despite efforts over the last thirty years, it is suggested that the construction industry is still in its early stages, compared to other waste streams such as municipal solid WM (MSWM), and yet to mature to effectively help alleviate the environmental burden (Hao *et al.*, 2007). How to reduce the generation of CD&E waste effectively is a challenge faced by many economies around the world. According to Yeung (2008), proper, efficient and economical routine management of CD&E waste is a challenge facing WM professionals worldwide. Since the 1980s, continuous research efforts have been devoted to figure out how to minimize the generation of CD&E waste in order to reduce associated adverse impacts during construction and demolition of building

structures (Yuan *et al.*, 2012). Previous studies have investigated a wide range of topics under the umbrella of CD&E WM ranging from CD&E waste reduction, recycling, to waste disposal. Lu and Yuan (2011) in making a framework for understanding CD&E WM developed the boundary for CD&E WM research as presented in figure 4.1.

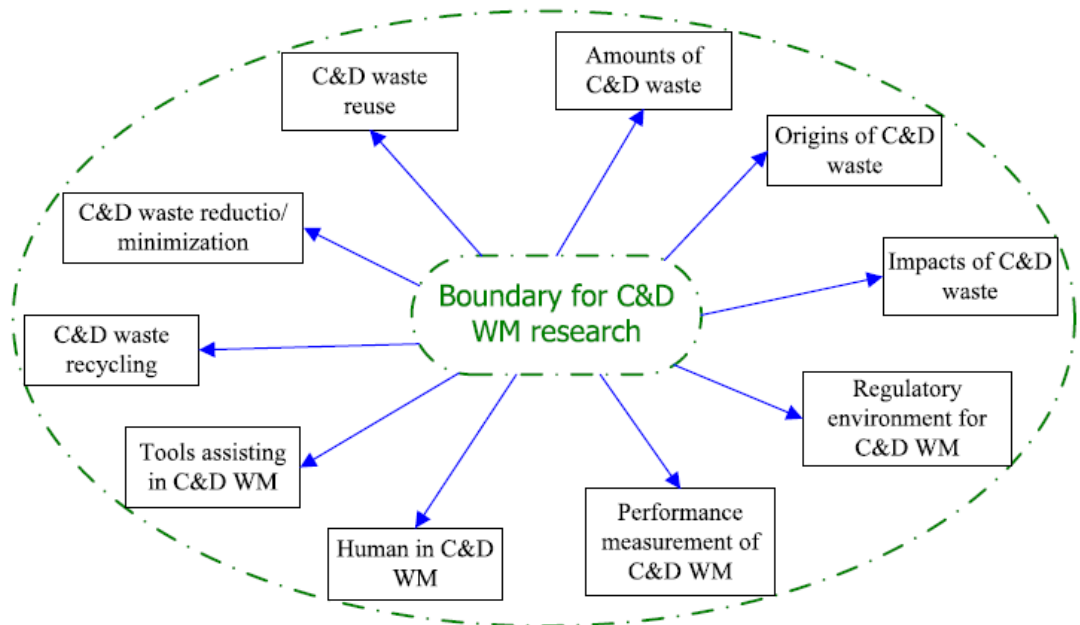


Figure 4. 1: Boundary of CD&E WM research.

Source (Lu and Yuan, 2011)

Yuan *et al.*, (2012) roughly categorized existing studies in relation to CD&E waste management into four themes, including: (1) barriers to implement CD&E waste reduction; (2) strategies for promoting CD&E waste reduction practices; (3) major stakeholders' attitudes/behaviours toward CD&E waste reduction; and (4) benchmarking CD&E WM performance through measuring and comparing waste generation rate (WGR).

Based on the boundary for CD&E WM research presented by Lu and Yuan (2011), the categorization by Yuan *et al.* (2012) and the review of literature within the boundary, this study analyzes WM studies and develops themes to cover all areas of CD&E WM.

### 4.3 THEMES IN CD&E WASTE MANAGEMENT RESEARCH

The themes for investigation CD&E WM were developed based on a review of over of over 230 research papers retrieved which focused mainly on the management of CD&E waste. The themes were mainly developed on the basis of the aims and objectives of the research papers.

Nine main themes were generated for CD&E WM studies and these are (in descending order of highly researched theme):

1. Waste Minimization (which also covers waste reduction and reuse);
2. Recycling;
3. Management of Waste on Site (Site activities and practices);
4. Economics of WM (Costs and Benefits of WM activities);
5. WM and sustainability;
6. WM and the environment;
7. Waste forecasting and measurement (quantification);
8. Human Factors in WM; and
9. WM legislation

The themes are analysed below.

#### 4.3.1 Waste reduction (minimization)

According to the review of literature done by Yuan and Shen (2011) for papers published from 2000 to 2009, waste minimization was the most researched area of CD&E WM. This is not surprising as the waste hierarchy proposed for the management of CD&E waste has minimization as the most important management option. For the purpose of this review, the waste minimization theme covers research works directed at both waste reduction and the reuse of waste but excludes studies on site WM practices (covered under the theme of Section 4.3.3).

Research works on waste minimization have been directed at one or more of the following areas: success factors for managing waste; methods for managing waste; identifying



sources of waste (this covers materials causing waste as well as activities producing the most waste); most preferred options for WM; effects of design on waste generation; reusing of materials; kind of construction/demolition technologies and their influences on waste; and Environmental Management Systems (EMS) and waste.

#### **4.3.1.1 Factors for waste Minimization**

Though WM is regarded as being complex, these studies try to reduce the complex nature into manageable but critical factors which can help in the management of CD&E Waste (Urio and Brent 2006; Begum *et al.*, 2007; Yuan and Lu, 2010; Osmani, 2012). The focus is on the various inputs (critical factors) that have bearing on ensuring waste is properly managed. These studies mainly use factor analyses to determine the most important or critical success factors. Though these studies do not always produce the same results, similar success factors are identified. From all the studies, critical factors for CD&E WM are: WM Legislation (Yuan and Lu, 2010; Osmani, 2012..); WM systems (Urio and Brent); awareness of WM (Manewa *et al.*, 2007); availability of technologies for WM; training of site personnel; buying of reusable/recyclable materials (Begum *et al.*, 2007); active participation of management; cost considerations (Hao *et al.*, 2010); close collaboration between designers, managers and the supply chain; and effective material control (Urio and Brent, 2006).

#### **4.3.1.2 Methods for waste Minimization**

Like any managerial activity, different methods or strategies can be used in CD&E WM. Studies of this nature either compare strategies for WM or try to find best strategies for which types of activities. A major area is the development of WM systems for construction activities. This is from the backdrop that WM systems are dynamic and interdependent and as such all aspects of management are required to select most appropriate strategies. Scenario building and model developments are the main types of studies done in this area (Rocha and Sattler 2009; Hao *et al.*, 2010; Yuan *et al.*, 2012; Vivanco *et al.*, 2012). These models and scenarios are used to cover all the aspects of construction process before work begins to allow management strategies to be identified before (Yuan *et al.*, 2012). According to Vivanco *et al.* (2012), scenario building is useful in assessing outcomes of hypothetical situations which provides adequacy for strategic planning. These studies

suggest approaches such as: adoption of effective material control on site (Urio and Brent, 2006); and incorporation of source separation as a WM option (Chung and Peon, 1996), Strategic/early planning (Poon, 2007).

Another area largely studied under methods of minimizing CD&E waste is the comparison of various construction methods to determine one most appropriate in waste reduction. Whereas some compare deconstruction (selective demolition) and traditional demolition (Coelho and de Brito, 2011; Denhart 2010; Dantata, Touran and Wang, 2005), others compare different kinds of construction methods: Conventional (traditional) as against precast construction i.e. mixed and integrated building systems, (IBS) (Kumar *et al.*, 2012; Hua *et al.*, 2010). The studies on demolition and deconstruction suggests that though demolition is cheaper than deconstruction, (as the main cost in demolition is the cost of disposal), deconstruction has an added advantage of leading to salvaging a lot of the materials which can either be reused or recycled for other activities (Denhart, 2010; Coelho and Brito, 2011). Deconstruction is also favoured because there is low likelihood of contamination of the materials salvaged and fewer materials are likely to be landfilled from deconstruction as against demolition. It is recommended that higher landfill charges for waste disposal will be an incentive to promote deconstruction which will then lead to a reduction in the amount of new materials used in construction projects.

Comparisons of traditional and modern building systems indicate that, current construction technologies are preferred so far as reduction of waste generation is concerned. The call for the use of sustainable and ecological friendly construction technology demands a change in the traditional construction models to enhance the capacity of recycling and reuse of waste from construction activities (Hu *et al.*, 2010). Lachimpadi *et al.*. (2012) compared Industrialised Building Systems (IBS) precast and conventional construction methods in Malaysia and report that IBS is the most efficient method of construction as it produces the least amount of waste and has a waste usage efficiency of over 94% whereas conventional construction produces the highest levels of waste and has the lowest reuse efficiency.

#### 4.3.1.3 Reuse of waste from CD&E activities

Reuse or preparing for reuse is the second most preferred option for WM according to the waste hierarchy. It entails the reuse or preparing for reuse (cleaning) of materials from waste without going through any processing. It is surprising to note that, though this is the second most preferred WM option, it is one area of WM which has received very little research (Lu and Yua, 2011). The majority of the very few studies on this subject are even more concerned with the reuse of recycled construction and demolition waste. Main themes studied are: properties of materials from construction and demolition waste (both physical properties and strength); economics of reusing waste materials; environmental impact of reusing waste materials; and how public perceptions affect the reuse of materials. According to Chidioglou *et al.* (2008), majority of the research on the properties of waste materials concentrate on the strength of the materials through shear box and triaxial tests. The authors then conducted a research on the physical properties of demolition waste (such as particle shape, water absorption and freeze-thaw resistance) for the purpose of reuse and the results indicate that findings of research on properties of demolition materials cannot be generalized as many different types of materials are produced due to the different composition of materials. Taha *et al.*, (2004) by looking at the strength properties of demolition waste report that it is feasible to partially reuse some of the materials from demolition and construction waste provided economic and environmental concerns allow it.

Economic concerns play a major role in reusing CD&E waste and many studies have been concerned with the costs and benefits of using CD&E W materials. Due to the overarching objective to reduce cost and increase profit margins, contractors or managers will pursue a waste minimization activity only if it will have a positive effect on project cost.

According to Chidioglou *et al.*, (2008) it makes both environmental and economic sense to recycle/reuse demolition waste products, particularly crushed concrete and bricks, since it will both reduce the amount of primary aggregates extracted and waste landfilled. To encourage reuse, Begum *et al.*, (2007) suggest that, during the procurement of materials, attempts should be made to purchase materials which have reuse packaging or are recyclable. Da Rocha and Sattler (2009), explore the major social, economic and legal

factors which can act as barriers or opportunities in the reuse of building components. They model the reuse process based on the supply chain method (SCM) and conclude that the reuse process is favoured by economic and social aspects such as the labour cost of deconstruction and demand for reused products.

#### **4.3.1.4 Sources of waste**

Knowing the source of waste is critical to waste minimization as this can lead to separation at source to enhance the reuse and recycling potential (Chung and Poen, 1996; Poon *et al.*, 2001), and to allow management efforts to be directed at the activities or materials which demand most attention. Ability to predict waste is seen as the first step in waste minimisation (Hobbs *et al.*, 2011) as practical WM requires a detailed understanding of what causes the waste. Majority of these studies have centred on the activities that cause the most waste and the type of materials most wasted on construction sites. Sources of waste can be found throughout the project life cycle from the initial design to the end of a project's life (Manewa *et al.*, 2007). Gavilan and Bernold (1994) organize sources of construction waste into six categories of design, procurement, material handling, residual related, operational, and other sources. Ekanayake and Ofori (2000) in doing a source evaluation of construction waste in Singapore further group waste sources into design, operational, material handling, and procurement sources.

Though WM is normally pursued at the construction stage, according to Bossink and Brouwers (1996), the client and designer can contribute by making environmentally friendly choices in the programme of the demands and design. The waste source identification model developed by Bernold and Gavilan (1994) identify design and detailing errors, design changes, procurement errors, errors due to inadequate material handling, and other external disruptions as important sources contributing to waste. Ekanayake and Ofori (2000) identify design changes when work is in progress as the most significant source of waste in construction. Though a major source of waste from construction sites is as a result of design (Rounce, 1998), *Osmani et al.* (2008) in studying perspectives of architects on waste reduction report that WM is not a priority in the design process as architects are generally of the view that waste is mainly produced during site operations and rarely generated during design stages.

Aside design sources, a lot of the waste generated on site can be attributed to many process sources such as: poor performance of workers (Manewa *et al.*, 2007); procurement methods (Gamage, Osmani and Glass, 2008); offcuts from cutting materials; improper storage space and methods; and application processes (Osmani *et al.*, 2006). A small variety of materials are responsible for most of CD&E waste and they relate to design and operational activities. Poon, *et al.*, (2004) report timber formwork as a major contributor of construction waste followed by wet trades finishes such as screeding, plastering and tile laying (collectively as second). Concrete, masonry works and material handling followed in that order.

Skoyles and Skoyles (1987) categorise waste sources into structure waste, and finishing waste. Structure waste includes concrete fragments, reinforcement bars, abandoned timber plates and pieces whereas finishing waste includes: surplus cement mortar arising from screeding; broken materials like mosaic tiles; ceramic; paints; and plastering. Other studies identify concrete as a major material that is wasted in the construction industry and reducing the application of wet trade has been recommended (Ho, 2001). To help minimize waste in construction, close attention needs to be paid to minimizing waste at all levels of construction activities from labourers to site managers (Zhang *et al.*, 2005). Prefabrication and modular construction in buildings have been suggested as low-waste construction technologies for reducing CD&E waste (Jaillon *et al.*, 2009; Cosgun 2007).

### **4.3.1.5 Environmental Management systems (EMS)**

Another area of study on the reduction of construction and demolition waste is how EMS(s) affect waste reduction. These management measures are considered with the protection of the environment and a contribution to sustainability as basis and adopt environmental management systems as a norm or reference model. This according to Rodriguez *et al.*, (2007), is gradually enhancing the environmental awareness of all personnel. Detail analyses of these kinds of studies can be found under the WM and environment as well as WM and sustainability themes of this review.

### 4.3.2 CD&E Waste Recycling

Waste recycling, though ranking third on the waste hierarchy is the most studied/researched CD&E WM area after waste minimization. Recycling of CD&E waste is promoted as a sustainable method for managing CD&E waste. A great deal of literature exists regarding the recycling of construction and demolition waste. An environmental advantage to underline CD&EW recycling is that it enables large quantities of resources to be used rationally which otherwise would have to be extracted from the diminishing stock of non-renewable resources (Merino *et al.*, 2009).

Studies on recycling can be put into three: factors affecting the recycling of CD&E waste (Huang *et al.*, 2002; Strufe, 2005; Duran, Lenihan and O'Regan, 2006; Merino *et al.*, 2009).; the properties of waste and properties of recycled materials and products (Soutsos *et al.*, 2004; Bianchini *et al.*, 2005; Townsend, *et al.*, 2007); and the kind of materials that can be or that are produced from recycled construction and demolition waste and the level at which these materials are used (Tam and Tam, 2006; Ulsen *et al.*, (2012; Galbenis and Tsimas, 2006).

#### 4.3.2.1 Factors affecting recycling of CD&E waste

There exists a number of research works dedicated to finding factors to help in recycling decision making. The review of the research area shows that these factors are mainly: economic (Poon, 1996; Huang *et al.*, 2002, Duran, Lenihan and O'Regan, 2006); environmental (Huang *et al.*, 2002; Strufe, 2005; Dosho, 2008); and technical (Dosho, 2008; Merino, Gracia and Azavedo, 2009).

Though recycling can produce high quality aggregates, Poon (2007) points that cheap means of disposal and no imposition of aggregate tax and conservative specification are barriers that affect its use. Duran *et al.* (2006), Robinson *et al.* (2004) and Taha *et al.*, (2004), all support the use of high landfill disposal cost to encourage recycling whereas Poon, (1996) recommends appropriate legislation should be used to control disposal and encourage recycling. Lawson *et al.*, (2001) state that appropriate risk analyses needs to be undertaken to increase the use of waste as new quarried materials (risk to environment).

On the efficiency of recycling CD&E waste as a source of resource, Yuan *et al.* (2011) suggest that other factors such as social, environmental and sustainability be incorporated as part of the traditional economic analyses.

Huang *et al.*, (2002) conduct feasibility studies on recycling in relation to technical, institutional and economic considerations and conclude that if a stable secondary materials market and institutional settings are sufficient, the only other factor required for recycling is the cost- benefits analyses. Rao *et al.* (2007) study on use of recycled aggregates and suggest that major barriers to adoption are: lack of awareness; lack of government support; and non-existence of specifications/codes for reuse. Dosho (2008) give the factors for ensuing reuse of recycled materials as assurance of safety and quality, reduction in environmental impacts and increase in cost effectiveness of construction. To ensure pollution from use of recycled materials is reduced or eliminated, Strufe (2005) recommends the authorities and research sector to develop guidelines and specification for clean removal and handling of building wastes.

#### **4.3.2.2 Properties of recycled CD&E W**

The properties of recycled CD&E waste materials to a large extent, determine usability. Studies on properties of recycled materials have mainly been laboratory experiments and are aimed at determining how these materials meet the standards required for their use. Researchers such as (Hansen 1986; RILEM 1994, Barra de Oliveira & Vasquez 1996) have studied the mechanical properties and durability (Banthia and Chan, 2000;., Rahal 2007; Del Río *et al.* 2006) of concrete made with recycled aggregates. Findings show that the mechanical properties depend on the characteristics of the concrete from which the aggregate is produced and the percentage used in the new concrete (Miranda and Selmo, 2003). Townsend *et al.* (2007) research the environmental issues associated with asphalt shingles recycling and use lab analyses to determine the properties and how they impact on the environment.

Bianchini *et al.*, (2005) conduct a chemical analysis of recycled inert materials to determine their suitability for the production of mortar, cements and bricks/tiles. Soutsos *et al.*, (2004) also study the strength properties of blocks produced from recycled materials and conclude from laboratory analyses that the physical properties of CD&EW aggregates adversely affects the mechanical properties of the blocks. Paravithana and Mohajerani, (2006) study the effects of recycled concrete aggregates on the properties of asphalt concrete and results showed that aside the percentage of air voids, all volumetric properties of asphalt produced with recycled materials were relatively lower compared to those produced using fresh concrete. These studies shed more light on the need to take the properties of materials into consideration when proposing use of recycled materials.

#### **4.3.2.3 Materials and Usage of recycled CD&E waste**

The purpose of recycling waste from CD&E activities is to contribute to the production of secondary materials that can be used in place of primary materials or natural resources. It must be said however that majority of the materials that are referred to as recycled from CD&EW are actually ‘down-cycled’ as they are mostly used for works demanding lower strength and performance (Soutsos *et al.*, 2004). Tam and Tam, (2006) review different construction materials and the technologies for recycling and conclude that the most common recycled material produced is recycled aggregates for low-grade applications.

Some studies however have also been concerned with how to produce same quality or even higher quality materials ‘Up-cycling’ from CD&EW. Ulsen *et al.*, (2012) propose a method that can be used for the production of high quality sand from CD&E waste. Mymrin and Correa, (2007) conduct a study on how to produce new construction materials for the production of high quality concrete. Galbenis and Tsimas, (2006) investigate the possibility of utilizing recycled CD&E waste as a substitute for the production of clinker cement. The production and use of these materials (low grade or high grade) however depends on the availability of technologies for production as well as market (acceptability) of the materials so produced.



#### 4.3.2.4 Methods for the recycling of CD&EW

Different methods have been utilized in the process making the secondary materials from CD&E Waste. The method of recycling will have an effect on the properties of materials produced and this will in turn affect the performance of the material. Huang *et al.*, (2002) study a mechanical sorting process for recycling CD&E waste. Mulder, de Jong and Feenstra, (2007) and Weil, Jeske, and Schebek, (2006) propose the concept of closed cycle construction for the recycling. Tam and Tam (2006)'s review of the technologies for recycling conclude that the need for viable technology for various types of construction materials is invaluable for the industry.

#### 4.3.3 Practices on Construction Sites

Though waste sources can be from both on and off site activities, it is said that many resources can be conserved and the amount of CD&E waste required to be disposed of would be greatly reduced if better management of materials is practiced on building sites (Poon, Yu and Jaillon, 2004). Practices on construction sites cover: waste handling processes; implementation of site WM plans and methods and their effectiveness; factors for reducing wastes on sites; and review of site activities leading to waste production. The application of WM methods as part of project management functions is suggested from the literature (Shen and Tam, 2002; Tam 2008; Shen *et al.*, 2004; Manewa *et al.*, 2007) as a requirement to ensure reduction in waste and its effects on project cost and the environment.

##### 4.3.3.1 Waste Flow (handling on sites)

Waste or material handling which is an aspect of material control is known to contribute to WM on construction sites (Ferguson *et al.*, 1995). A close examination of material cycle on site shows that a relatively large portion is wasted because of poor material control on site (Poon, Yu and Jaillon, 2004; Bernold and Gavilan, 1994). Some studies have been done linking standardization of procedures on sites to waste generation and management levels. Shen *et al.*, (2004) utilize the free flow mapping technique to investigate waste flow practices on construction sites and identify the lack of a standard practice for WM

procedure on sites as one of the essential reasons for absence of proper CD&E WM initiatives. Their study suggests that the many handling processes from generation to final disposal can induce various factors affecting WM effectiveness and thus require proper flow. Avoiding double handling is one of the measures proposed for reducing waste production through material handling on sites. Some studies also argue that even when these systems do exist, worker awareness as well as management commitment contributes in so many ways to make it work (Manewa *et al.*, 2007).

#### **4.3.3.2 Site waste management plans/techniques**

Due to the complex nature of WM on construction sites, there is the difficulty in establishing a methodology and using it to benchmark future projects. This according to McGrath (2001) is one of the major hindrances to waste minimization sites. Tam, Le and Zeng (2012), report the lack of a well-known effective WM method as the major difficulty encountered by organisations. A good WM plan or material control strategy can contribute significantly to eliminate waste sources and ensure waste is well managed (McDonald and Smithers, 1998; McDonald, 1998; Poon *et al.*, 2004; Urio and Brent 2006; Tam, 2007; Hill 2008). This method is encouraged among construction firms as it forms the basis for planning WM operations and provides a benchmark for measuring WM performance.

Various methods have been proposed for managing waste on construction sites and a notable one is a site WM plan (SWMP). In his studies on ‘waste minimization in practice’, McGrath (2001) developed a waste minimization system called ‘Site Methodology to Audit Reduce and Target Waste’ (SMARTWaste) for identifying and auditing waste arising on a construction site. In Hong Kong a Waste-Management-Plan (WMP) has been a requirement for all construction projects since 2003 (Tam, 2008). In the UK, site WM plans was first introduced as a voluntary code of practice by the Department of Trade and Industry in 2004 but became a statutory requirement in 2008 for all construction projects beyond a project cost of £300,000 excluding vat (Hill, 2008; SWMP2008). The legal requirement was however scrapped in December 2013. In Bulgaria, Brazil, France and many other countries, there are similar requirements for construction waste minimization plans or strategies. This is due to the recognition given to the importance of WM plans in

ensuring waste reduction on site. Though WM plans methods are criticized as being time consuming and negatively affecting productivity (Baldwin, 2010; Wrap, 2009; Tam, 2008), there is evidence to suggest that it positively affects WM on construction sites and when implemented properly has the ability to reduce cost and reliance on new materials.

### **4.3.3.3 Waste source separation**

Source separation is another construction site WM or reduction method that has received attention from both academia and industry. According to Cheung and Peon (1996), it is the most preferred option for managing waste on site. This is due to its ability to positively impact on land filling (Poon, Yu and Ng, 2001; Poon, Yu and Jaillon, 2004; Hao, Hill and Shen, 2007). This practice of sorting materials and separating them at the source helps to increase the rate of reuse and recycling which are the most preferred options of WM after reduction/prevention. According to Poon, Yu and Ng, (2001), source separation has an advantage of requiring less efforts and leading to better segregation of materials. Wang *et al.*, (2010) add other advantages such as reducing the cost for waste transportation and disposal, prolonging the lifespan of landfills designed for receiving non-inert construction waste, and lessening the pollution resulted from the huge amount of construction waste. The research by Wang *et al.* identified manpower, market for recycled materials, waste sortability, better management, site space and equipment for sorting of construction waste as critical factors for onsite sorting of waste.

Though a very good management practice on site, barriers such as increase in management and operation costs, lack of trained staffs and expertise, and lack of government legal enforcement (Shen and Tam, 2002) prevent its utilisation on construction sites.

### **4.3.4 Economics of CD&E Waste Management**

The need for economic analyses of WM is mainly from the side of the clients or contractors who are more concerned with how waste generation affects the cost of construction projects and the management activities that can be used to reduce this cost. To this group of people, WM is mainly motivated by the economic gains. It is evident that

there are enormous economic and environmental benefits to be gained from WM (Guthrie *et al.*, 1999 in Begum *et al.*, 2006). Economic benefits to be gained from WM are; reduction in the cost of transporting and disposing waste, reduction in the amount of material (bought and) used as the waste generated can be reused, reduction in the margins for waste used in contracts (this has the added advantage of reducing contract figures which can contribute to winning bids) etc.

Research on the economics of CD&E WM suggests that, market based instruments are likely to be the best option for policy makers in designing WM policies. A clear reflection of this is the Land Fill Tax system in the EU/UK which is seen as the main motivation for the reduction of the amount of waste sent to the Landfill. According to Lauritzen, (1998 in Begum *et al.*, 2006), it is economically feasible to recycle up to 80–90% of the total amount of CD&E waste and most demolition and recycling technologies are generally easy to implement and control. The economic benefits of waste minimisation and recycling include the possibilities of selling specific waste materials and the removal from site of other wastes at no charge or reduced cost, with a subsequent reduction in materials going to landfill at a higher cost (Snook *et al.*, 1995).

According to the US EPA (2002), waste minimisation makes good economic and business sense and at the same time, waste minimisation can improve production efficiency, profits, good neighbour image, product quality and environmental performance.

The benefit–cost analysis is important for the implementation of WM systems in the construction industry. The benefits come from all the direct, indirect and intangible benefits due to reusing and recycling of waste materials as well as the costs of all the direct, indirect and intangible costs involved of the reusing and recycling on the site. Costs are the key determinant of decisions and choices in WM technologies and practices (Chen *et al.*, 2002; Coffey, 1999; Goddard, 1995; Mills *et al.*, 1999; Poon *et al.*, 2001; Wang *et al.*, 2002). The cost for implementing WM is often given more concern than the possible benefits that the organisation can gain from the implementation (Shen and Tam, 2002).

The direct benefits of reusing and recycling consist of purchasing cost savings by reusing and recycling of construction waste materials and revenue from selling of scrap materials. The indirect benefits consist of waste collection and transportation cost savings and cost savings from landfill charge by reusing and recycling of construction waste materials. The net benefit of reusing and recycling of waste materials is estimated at 2.5% of the total project budget. Thus, the construction industry can save money by implementing waste minimisation practices on the site.

### **4.3.5 Waste management and sustainability**

A research by Chung and Lo, (2003) reveals that various concepts have been used to imply good WM; sustainable WM, integrated WM (IWM), holistic WM and WM hierarchy. In all these concepts, though the approach may be different the underlying quest is to apply a life cycle assessment to WM allowing a number of WM options to be used.

Based on the underlying principle of sustainable development, Tammemagi (1999) defines the goals of sustainable WM as (i) protecting health and the environment, (ii) minimizing the burden on future generations and (iii) conserving resources to this Chong and Lo (2003) add the economic requirement as the fourth.

The general definition for sustainability lies in our obligation to ensure the abilities of future generations to meet their needs and a more equal distribution of wealth for the present generation (ref). These studies can be grouped into two main categories. One group focuses on the criteria for evaluating sustainability in WM in the construction industry (Chung and Lo, 2003; Klang, Vikman and Brattebo, 2003; Uher, 2008) whereas the other focuses on sustainable management of construction and demolition waste and its accompanying problems (Craighill and Powell, 1999; Agamuthu 2008; Bjerregaard, 2008).

#### **4.3.5.1 Evaluation (Indicators) of sustainability in CD&E waste management**

The construction industry is said to impact severely on all aspects of environmental issues affecting sustainability (Uher, 1999). The endorsement of Agenda 21 of the Rio United Nations summit in 1992 requires methods for monitoring trends of sustainable development. Based on this, Klang, Vikman and Brattebo, (2003) present a model for evaluating WM for its contribution to sustainable development and tested it on how different WM options contribute to the various aspects of sustainability (economic, environmental and social). They concluded that, whereas a WM option may contribute positively to an aspect of sustainability, it may contribute negatively to another aspect. According to Chang and Lo, (2003) sustainability criteria for WM should be seen in terms of environmental desirability, economic optimization, social acceptability and equity and administrative diligence. To promote sustainable reuse of CD&E waste, Dosho, (2008) requires that the following three concepts must be achieved: (a) assurance of safety and quality, (b) reduction in environmental impact and (c) increase in cost-effectiveness of construction.

#### **4.3.5.2 Sustainable management**

Powrie and Dacombe (2006) argue that from a sustainability point of view, ‘waste’ should be viewed as part of a resource cycle that includes extracting materials and energy from the environment, refining raw materials and producing goods, consuming and using goods and then eventually returning materials to the environment (with waste from one process being used as resource inputs for another or even same process). The United Nations definition of Sustainable WM as the application of life cycle concept to WM has developed into the waste hierarchy which is currently adopted the world over. Dosho, (2008) outlines a review of a system for the production of recycled demolition concrete (using aggregate replacement method) which contributes positively to sustainability in terms of cost and environmental impacts. Though sustainable management is promoted at the high levels (national, regional, etc.), there is also a need to develop methods to evaluate sustainability and sustainable development on a smaller scale, such as in businesses or projects (Read, 1999 in Klang, Vikman and Brattebo, 2003). According to Merino, Gracia and Azavedo, (2009) to contribute to sustainability, the management mechanisms to be developed for

WM should embody environmental, economic and legal issues and cover all persons within the process.

### 4.3.6 Waste Management and the Environment

Development of environmental concerns over the years has contributed to the mounting of pressure on the construction industry to improve its attitudes towards the environment and ensure development is achieved with environmental management as an integral part. WM is a critical aspect of environmental management due to the need to decouple environmental pollution from the level of development (Bogner *et al.*, 2007, p.10). Construction and demolition WM is pursued from two main angles; on one side is the concern for the environment where as the other side is the economic gains from engaging in it (Yuan and Shen, 2011). The construction industry by its nature is known to be environmentally non friendly due to its negative impact on the environment mainly through the excess use of resources and the excess amounts of waste produced (EPD, 1998; Shen *et al.*, 2004; Tam and Tam, 2008). The industry generates about 35% of industrial waste in the world (Hendriks and Pietersen, 2000; Construction Materials Recycling Association, 2005) and this comes with it environmental issues. In places like Hong Kong, according to the report by the Environment Protection Department (EPD), about 2900 tons of CD&E waste was received at landfills per day in 2007 (Hong Kong EPD, 2007).

Studies relating the waste situation in the construction industry and the environment can be group into three; environmental impact of waste (Trankler, Walker and Dohmann, 1996; Kartam *et al.*, 2004), environmental impact of WM options (Townsend *et al.*, 2007; Coelho and de Brito, 2012) and the contribution of Environmental Management Systems (EMS) to CD&E W Management (Rodriguez, Alegre and Martinez, 2007). According to Shen *et al.*, (2004) the increasing awareness of environmental impacts from construction wastes has led to the development of WM as an important function of construction project management. This can also be said to be a contributing factor to the increase in research on CD&E waste and the environment.

#### 4.3.6.1 Environmental impacts of CD&E waste

The huge amounts of waste produced by the construction industry can be said to affect the environment in a varied number of ways. As Hao *et al.* (2007) put it; CD&E WM is still in its early stages and has not matured enough to effectively alleviate the environmental burden. Kjeldsen (2008) compares what CD&E waste and End-of-life refrigerators have in common and conclude that they both are environmentally unfriendly. He however states that regulations should not be made based on undocumented rough assumptions but on the emission behaviour of CD&E waste. There are a number of studies geared at understanding environmental impacts of CD&E waste to help inform policies or measures to protect the environment. Trankler, Walker and Max (1996) report that environmental impact of demolition waste varies based on the composition of the waste. Ortiz *et al.* (2010) use life cycle methodology to evaluate the environmental impact of the construction phase of buildings which includes WM.

Petkovic *et al.*, (2004) developed a method for assessing the environmental impact of using recycled construction and demolition waste to help set acceptable criteria for safe use. Jimenez *et al.*, (2012) study the environmental impacts of CD&E recycled aggregates in field conditions and conclude that for unpaved rural roads, there is no risk of environmental impact for use. The disposal to landfill of CD&EW also has impacts on the environment: leaching of the decomposition products of certain non-inert components (plaster, plastic, wood, bitumen, hazardous waste such as paints, etc.)

#### 4.3.6.2 Environmental impact of CD&E waste management Options

The promotion of WM options is in line with the best practical ways of ensuring the least effect of waste on the environment. Coelho and de Brito (2012) study the influence of construction and demolition waste on the environmental impacts of buildings and conclude that show that shallow, superficial, selective demolition may not result in reduced environmental impacts but core material separation in demolition operations and its recycling and/or reuse does bring environmental benefits. Strufe (2005) identifies source of



environmental impacts of demolition waste and recommends studies into the development of clean removal (handling) of building materials to ensure a reduction in environmental impacts. The principle of the waste hierarchy is developed with the environment as a focus. This covers firstly the obligation to handle waste without posing a negative impact on the environment or human health and secondly the hierarchy of the best overall environmental options in WM, from prevention to disposal (EC-European Commission, 2008).

### **4.3.6.3 Environmental Management Systems (EMS) and CD&E waste**

Studies linking WM in construction to EMS suggest that the application of environmental management systems is gradually enhancing the environmental awareness of all personnel in CD&E WM (Rodriguez, Alegre and Martinez, 2007). The application of such systems leads to the establishment of practical measures for the management of waste at construction sites. The achievement of EMS certifications (ISO 14000 environmental management standard scheme) would create an incentive for firms to take on board environmental challenges at design stage of the project (Davenport, 2003).

To help reduce the potential for CD&E waste to contaminate the environment in the European context, increased enforcement of CD&EW regulations, encouragement of industry to identify and apply appropriate recycling measures and increased tipping fees for disposal are seen as the main incentives.

### **4.3.7 Waste Quantification**

Construction activities not only consume a large amount of natural resources, materials and energy (around 40% of all materials Kulatunga *et al.*, 2006), but also generate unacceptable levels of waste (Yuan *et al.*, 2011). According to Hobbs, Adams and Blackwell (2011), the first step in any waste minimization effort is the ability to predict the amounts of waste. Construction wastes represent a large share among all types of solid wastes in the world (Poon, 1997). Waste quantification; measuring of produced waste and forecasting (prediction) of expected waste is an area of WM that has received attention

from WM researchers over the years. The theme of waste quantification as used in this report covers studies that have focussed on measuring waste production in the construction industry (whether site specific, regional or national) and the forecasting or prediction of the quantities and types of waste expected from construction activities.

These studies are critical as they aid in decision making of managers on construction sites as well as policy makers. Good waste volume prediction does not only allow good control of the generated waste but also good construction site management (Soliz-Guzman *et al.*, 2009). According to Manewa *et al.*, (2007) there is the need for a clear knowledge of the types of waste and how waste occurs before implementing ways or strategies to reduce wastage on sites. Waste generation rates of different materials (Lu *et al.*, 2011), models for predicting future volumes of waste (Hsiao *et al.*, 2002; Cochran and Townsend, 2010), and waste generation by kind of construction methods (Lachimpadi *et al.*, 2012) are some of the areas studied under this theme.

Various methods have been used by researchers to measure or forecast waste generation levels; comparing contractors' records (Skoyles, 1976), sorting and weighing the waste materials on site (Bossink and Brouwers, 1996), truck load records (Poon *et al.*, 2001a), direct observation (Formoso *et al.*, 2002), material flow analyses (Cochran and Townsend, 2010) and waste weight per construction area method (Franklin Associates, 1998; Hsiao *et al.*, 2002; Fatta *et al.*, 2003; Shi and Xu, 2006; USEPA, 2009; Yost and Halstead, 1996 in Cochran and Townsend, 2010). These estimation and forecasting studies have helped to identify the major material sources of waste in construction. These include formwork, temporary hoarding, steel reinforcement bar, scaffolding, finishes etc (Tam, Lee and Zeng, 2012).

According to Fishbein, (1998) CD&E waste frequently accounts for 10–30% of the solid waste received at many landfill sites around the world. Estimates of CD&E waste for different places around the world have been given in the literature. The U.S. Environmental Protection Agency (EPA, 2002) estimated that approximately 136 million

tons of building-related CD&E debris was generated in 1996. In UK, the wastage rates are as high as 10–15% (McGrath and Anderson, 2000) of all materials sent to site. In Australia, CD&E waste presents a significant proportion of the industrial solid waste going into landfills (Lingard *et al.*, 2001). In Hong Kong, between 1993 and 2004, the annual generation of CD&E waste more than doubled, reaching an amount of about 20 million tons in 2004 a single year (Poon, 2007).

These high wastage rates have effects on management measures as well as provision of landfill space for all wastes generated in any economy. Craven *et al.* (1994), Reported that construction activity generates approximately 20–30% of all wastes deposited in Australian landfills. Ferguson *et al.* (1995) found that more than 50% of the waste deposited in a typical landfill in the U.K. comes from construction wastes. According to Rogoff and Williams (1994), 29% of the solid-waste stream in the USA is construction waste. Dong *et al.* (2001), reports that China produces 29% of the world's municipal solid waste each year, amongst which construction activities contribute nearly 40%, consuming about 40% of total natural resources and around 40% of energy (also reported in Lu, 1999; Wang *et al.*, 2008). These statistics on the levels of waste produced by different countries vary from study to study based on the methods employed in calculating or estimating and the sources included or omitted. The fact however remains that CD&E W generation rate is very high the world over. One material most quantified is concrete and there are a number of research works specifically estimating or quantifying the levels of concrete wastage (Shi and Xu, 2006; Hsiao *et al.*, 2002).

#### **4.3.8 Human Factors in WM**

Like any managerial activity, the managing of construction and demolition waste is affected to a large degree by decisions and measures made by managers in charge of construction projects. According to Zhang *et al.*, (2005) close attention needs to be paid to minimizing waste at all levels of construction activities from labourers to site managers to help minimize waste in construction. Teo and Loosemore (2001) studied the theory of waste behaviour in construction, and report that majority of the research on CD&E WM were neglecting the important influence of people's willingness to change their attitudes

and behaviour. Being a labour intensive industry, some researchers are of the view that the human factor should have a high place in management efforts or considerations (Skoyles and Skoyles, 1987; Heino, 1994; Soibelman *et al.*, 1994; and Olomolaiye *et al.* 1998).

The theme of human factors in CD&E WM looks at the various aspects of WM that are affected by the personnel involved in the construction process; clients, designers, project managers all the way down to operatives on construction sites. Central to the theory of planned behaviour is behavioural intention and this is determined by attitudinal, social and perceptual factors (Teo and Loosemore, 2001). Studies on human factors in WM can be grouped into three main categories. They cover attitudes towards WM, perceptions of WM, and measures for managing waste (including factors that affect them to enable managers to focus their change efforts more effectively).

#### **4.3.8.1 Attitudes towards WM**

Whether consciously or not, behavioural decisions are frequently based upon attitudes (Fabrigar, 2004). Attitudes represent peoples' evaluations of objects or situations that predispose them to behave in a certain way (Rokeach, 1972; Ajzen, 1993). Knowing about attitudes towards waste and factors affecting it will enable managers to focus their effort more effectively. Findings from Yuan and Shen (2011) and Teo and Loosemore (2001) demonstrate that it is crucial to take the attitudes of major practitioners into consideration when seeking a workable solution for waste reduction. Studies on attitudes have been directed at architects and construction personnel (management and operatives). Lingard *et al.* (2000) sampled views on people's attitudes and behavioural tendencies towards WM. By using Ajzen's 'theory of planned behaviour', Teo and Loosemore (2001) examined the attitudinal forces that shape operatives' attitudes toward CD&E waste reduction.

Whereas designers attached little importance to designing out waste, Poon *et al.*, (2004), Osmani, Glass and Price (2006) and Begum *et al.* (2009) report that contractors generally have positive attitudes towards WM but attitudes tend to differ based on size of the contractor. Large contractors have a more positive attitude towards waste than medium

contractors. According to Osmani, Glass and Price (2006), whereas architects blame contractors for waste generation (lack of forward planning, poor reading of information and failure to follow specification and details) contractors blame this on buildability of designs (architects), and poor management by subcontractors and conclude that Poorly defined responsibilities are leading to confusion on who should control and monitor WM. Taking this into consideration, it can be concluded that all players in the construction industry have a role to play in ensuring the management of waste.

### **4.3.8.2 Perceptions of waste management**

Perception is an integral aspect of behavioural intention and this is known to affect motivation to behave in certain ways. This factor according to Ajzen (1991), refers to an individual's perception of the ease or difficulty of performing the type of behaviour, and reflects past experiences as well as anticipated obstacles to doing so. Perceptions have also been studied at the levels of construction professionals and workers. Teo and Loosemore, (2001) report that operatives perceive waste as an inevitable by-product of construction activity. It continues that though attitudes are not negative, they are pragmatic and impeded by perceptions and a lack of managerial commitment. From Osmani, Glass and Price, (2006) contractors see this perception of waste being inevitable as a major factor affecting WM. Hwang and Yeo, (2010) study the effects of project characteristics on perceived benefits of WM and report that the key materials used, project size (in terms of cost) and project type are factors affecting perception of management. Perceptions of architects are that waste generation is from the construction phase of projects and not from design.

### **4.3.8.3 Waste Management Actions**

Perceptions and attitudes determine WM actions or strategies put up by managers. Herremans and Allwright (2000) demonstrated that posture, which includes awareness and attitude, leads to action and performance (behavior) regarding environmental management issues. In the case of construction WM, Hao *et al.*, (2010) conclude that active participation by participants in WM and cost considerations are the major affecting factors. Knoeri, Binder and Althaus, (2011) analyze construction stakeholders' behavior, and decision-making regarding use of recycled materials for construction in Austria and report

that such decisions are based on recommendations from other stakeholders such as engineers. Managers are seen as the main source of responsibility for WM efforts in the construction industry. Various managerial measures, such as promoting best WM practices, have been developed to manage CD&E waste based on the view that it is a behavioural and social process (Shen *et al.* 2004; Jaillon and Poon 2008).

### 4.3.9 Waste Management Legislation

The concern for CD&E waste is multiple folds; running up a large amount of land resources for waste landfilling (Poon *et al.*, 2003), harming the surroundings by hazardous pollution (Esin and Cosgun , 2007), wasting natural resources (Yuan and Shen , 2011) and increase in the cost of construction projects. Of all the concerns, the negative effect of CD&E waste on the environment is the main reason why governments have been involved in its management. There are two main concerns for CD&E WM; environment and cost. Whereas contractors are more concerned with the economics of WM, government's focus is on the environment and this is pursued mainly through WM legislation and policy. CD&E W has been identified as a 'Priority waste stream' by the member states of the EU and is the largest waste fraction in society (Thormark, 2002). A number of legislation have been passed seeking to manage the waste and its effects on the environment.

The role of WM legislation in contributing to WM and reduction cannot be over emphasized. Many researchers (Seydel *et al.*, 2002; Begum *et al.*, 2007; Osmani, Glass and Price, 2008; Wang *et al.*, 2010) have stated the key role in which CD&EW legislation plays in reducing its effects on the environment. This theme looks at studies that have been conducted specifically with WM legislation as the main focus. The review shows that not much has been done in this area of research as compared to Municipal Solid Waste (MSW of which often CD&EW is excluded). Majority of the studies covering CD&E waste legislation are targeted at evaluating WM policies or legislation (Bossink and Brouwers, 1996; Waddell, 2008; Adams, 2008; Mudgal *et al.*, 2011). The remaining are done reviewing particular waste legislation and factors affecting compliance (Price, 2010; Baldwin, 2010).

#### 4.3.9.1 Evaluation of CD&E Waste management legislation

Many researchers have concluded that WM legislation is critical in ensuring sustainable management of CD&E waste and protecting the environment. This is because contractors on their own will not pursue WM where there are no economic incentives. Research evaluating waste legislation review policies of governments and how they are contributing to WM. In the EU member states, policies concerning waste are now determined at the regional level and member states made to implement these policies. Mudgal *et al.*, (2011) conduct a research on the coherence of waste legislation for the European Commission. Though this research is not on construction and demolition WM, it covers waste streams of which CD&E waste is part. The work covers potential gaps, inconsistencies and overlaps between the waste stream Directives and other elements of EU waste legislation; the effectiveness and efficiency of the current waste stream Directives; and potential alternative approaches in the design of legislation as well as upcoming challenges for the EU waste legislation related to recycling. This study recommends that management of CD&E waste and materials could benefit from more comprehensive regulatory provisions (European Commission (DG ENV), 2011).

Bossink and Brouwers, (1996) present an overview of the main policy areas of the Dutch government on sustainability of which CD&E WM plays a key role. Waddell, (2008) takes a brief look at UK legislation and government policies in relation to sustainable construction and how it will affect activities in the industry. Adams, (2008) reviews sustainable WM for England and framework for waste policies by analysing the requirements of the industry through the waste strategy and legislation. Jeffrey, (2011) does a literature review of CD&EW recycling and analyzes CD&E WM policy and legislation in the EU, Canada and some other countries in the world whereas Garbutt, (1995) though not exactly a CD&E WM study looks at the EU policy on WM of which CD&E waste is an essential part and how it is impacting on recycling.

#### 4.3.9.2 CD&E Waste legislation and compliance

Though there are quite a lot of studies done on compliance with municipal waste legislation, same cannot be said about waste from construction and demolition. Few studies in the UK have been done on the SWMP2008 legislation purposely for construction and demolition WM. Waste Resources Action Program (WRAP, 2009); conduct an impact analysis of the SWMP 2008 and reports that compliance levels are low. Price, (2010) looks into the responsibilities and risks posed by the SWMP2008 to the principal contractor of the CDM2007 and makes recommendations as to how to ensure the roles are well laid out. Baldwin (2010) investigates the reasons why the SWMP2008 has failed to live up to its motives and reports that certain responsibilities are not placed in the legislation. IEEP, (2012) reports that WM in the EU is improving but implementation of Legislation by member states remains patchy. The need to get legislation right from the start through better impact assessment is recommended. Sáez *et al.*, (2011) review EU legislation and implementation measures in the management of CD&E waste and conclude that the EU is still far away from reaching the recycling target for 2020. There is still need to improve national and European legislation towards the correct management of the CD&E waste generated during construction activities. Davenport, (2003) reviewed the impact CD&E waste legislation is having on the construction industry in the UK and concludes that a major problem for contractors is the sheer complexity of national as well as EU laws impacting on CD&E WM and the burden of high compliance cost which leads to non-compliance.

#### 4.4 TYPES OF STUDIES AND METHODS OF ANALYSIS

Different types of studies and methods of analyses have been employed by various authors in researching CD&E WM. Within the same theme, there are yet different methods and types depending on the nature of information the research sought after. This section analyses the various WM themes on the basis of the types of studies and the methods employed in analysing the data so presented. The change in the method of analyses over the years is also analysed to see the trend in change over time. Analyses of the countries of authors or contributions from countries on the various themes are also presented.



### **4.4.1 CD&E waste reduction**

This is the most researched area of CD&E WM and the highest priority in WM as displayed in the waste hierarchy. Due to the high priority given to waste minimization in the waste hierarchy, a lot of research has been done in the area and the research cuts across many countries and activities both on site as well as offsite activities. Countries like, Hong Kong, UK, USA, Malaysia and Portugal (in descending order) have the highest percentage of these studies.

Due to the live nature of waste minimization studies, case studies and surveys are the most used methods in these studies. It mostly involves the options available to managers for waste reduction as well as the factors that will contribute or hinder waste minimisation efforts.

Statistical analysis is the method used by most of the early researchers in this area. This is mainly used to find how well an option or an activity will contribute to waste minimizations. Some researchers also use productivity ratings for the performance of WM options or methods where as others use multiple criteria analyses to determine how best options meet or are fit for waste minimizations.

Recent studies however have used a mixture of more robust methods for analyses of their data. Whereas some studies employ the use of factor analyses to determine the degree to which various factors affect or contribute to waste minimisation (critical success factor approaches), some have employed material flow analyses to track the flow of materials in the construction process to determine what stages or works contribute most to waste generation to be able to determine management actions or practices well suited for reduction. Due to the complex nature of the WM process in the construction industry, some more recent studies have employed modelling techniques like system dynamics models to simulate the WM process before hand to enable the identification of sources and causes of waste generation and best practices for reduction.

### **4.4.2 CD&E Waste Recycling**

This is the single most researched area of WM and studies on recycling date as far back as the 80s. Though third on the waste hierarchy, it has received a lot of attention due to its

immense contribution to sustainable WM. Studies on recycling cover both on site as well as offsite activities. In decreasing order, USA, Hong Kong, UK, Brazil and Australia have contributed most to the research area. Due to the broad coverage of the study area, various types of studies have been employed on waste recycling. Surveys, reviews, case studies as well as experiments have all been utilized by researches on recycling. Whereas surveys and case studies are mainly used for the practice of recycling such as factors affecting recycling, experiments are employed in determining the properties and performance of recycled products or materials from CD&E waste.

Due to majority of the studies being laboratory experiments and finding of material properties, statistical analyses are mostly employed in finding the levels of certain chemicals in the materials. Factor analyses are also used to determine the causes and presence of certain materials in the recycled products as well as factors that will lead to the promotion or otherwise of recycling activities.

New trends in the studies of recycling employ the use of modelling techniques and scenario building to determine the recycling process and measures needed to enhance it. Zhao *et al.* (2011) utilize systems dynamics model to determine the type of recycling centres most appropriate for recycling. Spoerni *et al.*, (2009) employ Formative Scenario Analyses (FSA) for planning recycling activities. Some case studies and surveys utilize Emergy theory/analyses to determine the efficiency of the recycling process. Cost-benefits analyses (CBA) are also employed by some studies for determining the economics of recycling (Tam 2008, Zhao *et al.*, 2010).

### **4.4.3 Practices on Construction Sites**

This area is an aspect of waste minimization or management but looks only at activities that are done on site to manage CD&E waste. Studies have mainly been conducted in Hong Kong with few in the Netherlands, UK, Turkey and Spain.

Case Studies, Surveys and Reviews are the main types of studies used in examining the WM processes and procedures on sites and their effectiveness as well as the reasons for implementing a particular strategy or the other.

Early researches use statistical analyses for determining factors that lead to good management practices. Some old studies also employ free flow mapping analysis of construction site practices.

Recent studies have employed a variety of complex methods and approaches. Modelling appears to be the current approach to studies on site waste practices and it is employed to model practices and activities on site for managing waste. Systems dynamics, material flow analyses (Vivanco *et al.*, 2012) and scenario building are used to assess outcomes of hypothetical situations to aid in strategic planning. Spectra and Bispectra of data are also used by Tam, Le and Zeng, (2012) to assess implementation of existing WM systems.

#### **4.4.4 Economics of WM**

Studies on economics or cost benefit analyses of WM options have been conducted mainly in USA, China and Australia.

Studies on economics of WM have mainly been case studies or surveys where different WM methods are compared to find the most economical one. Some of these studies also compare the cost of engaging in WM activities as against the economic gains from it. The main types of analyses employed in this area of study are cost- benefits analyses or statistical comparative analyses. Here cost of WM is compared with gains to measure the economic incentives gained from the WM practices.

Though some of the recent studies also employ statistical cost benefits analysis others have moved away from the traditional statistical or cost benefits analyses and are employing the use of models or simulations which have the advantage of covering other costs which would not be covered by traditional methods an example is Da Rocha and Sattler, (2009) who employ the close loop supply chain method. Zhao and Rotter, (2010) also use cost

estimation and investment analyses to determine the costs and benefits for engaging in recycling.

### **4.4.5 WM and Sustainability**

Though not one of the most researched areas in CD&E WM, the area of sustainability has received some attention from researchers mainly UK based researchers.

The main types of studies relating to sustainability in WM are Case studies and surveys. They are mainly focused on how a particular management option contributes more or less to sustainability or setting the factors needed for measuring sustainability of WM.

Analyses have mostly been factor analyses for both recent and old studies. Life cycle impact assessments are normally applied to various WM activities to determine how they contribute to sustainability (evaluation). Some studies have also employed the use of models to analyse the sustainability of WM options (Klang *et al.*, 2003).

### **4.4.6 WM and the Environment**

This area has received attention mainly from Denmark, Spain, USA and Germany.

Due to the nature of the study area, experiments and surveys have been the main types of studies employed. This is because the studies are mainly geared towards measuring the environmental or pollution effects of waste on the environment or how environmentally sound or unsound a particular WM method or practice is.

Lab analyses have been the main method of analysing data from these kinds of studies and they normally employ statistical analyses. Some recent studies have also employed processed based life cycle analysis to determine the effect various processes within the WM cycle have on the environment (Coelho and Brito, 2012). Yuan *et al.*, (2012) utilise system dynamics to determine how management measures impact on environmental performance of WM.

#### 4.4.7 Waste Quantification/Forecasting

Studies measuring waste levels and forecasting of expected amounts of waste from construction activities have been conducted in many countries with majority of the studies coming from Hong Kong, USA, China and other countries.

Types of studies under this subject area are mainly surveys, reviews and case studies. Surveys and reviews are used to measure the amounts of generated waste from construction activities whereas case studies are used mainly to predict or forecast expected levels of waste from activities.

Statistical analyses have been the main method employed for waste quantification studies as studies have normally dealt with measuring or quantifying waste levels. Some of the recent studies however have employed more rigorous techniques or methods of analyses and the use of software like iThink. Cochran and Townsend, (2010) use material flow analyses which benefits from improved estimation of materials where as other studies employ Grey Forecasting model. Some recent studies also use statistical analyses from comparative activities (Lachimpadi *et al.*, 2012).

#### 4.4.8 Human Factors in WM

Studies on the attitudes and perceptions of the people involved in the WM process have received some attention from researchers mainly from Hong Kong, UK, Australia etc.

Due to the kind of study, surveys and reviews are the main types of studies that have been conducted.

Quantitative statistical analyses are mostly used to determine the degree to which attitudes or perceptions affect the actions relating to WM (from both architects and managers down to labourers). Recent studies however have employed a variety of complex models from the basis that attitudes are affected to various degrees by different factors. Begum *et al.*, (2009) use Logistics regression model to assess the relationship between various factors where as some studies employ Simulation techniques using system dynamics model to measure how management measures affect performance in WM. Analytical Hierarchy Process (AHP) is employed by Knoeri, *et al.* (2011) to quantify decisions regarding recycled construction materials.

#### 4.4.9 WM Legislation

Though a number of studies have been conducted in this area, compared to other areas in CD&E WM, not much has been done. Majority of the few studies have been conducted mainly in the UK, Spain and USA. Surveys or reviews are the main types of studies conducted as they are normally impact studies, evaluation or review of the effect of certain legislation or policies and how they affect WM and compliance.

Qualitative analyses are normally used in these kinds of studies. Statistical analyses are employed when the research involves surveys which are aimed at finding levels of compliance with legislation as well as problems or factors affecting compliance. Some of the review papers do comparative analyses of effects of legislation on WM performance and compliance through qualitative analyses (see e.g. Sáez *et al.*, 2011; Davenport, 2003).

A summary of studies in the area of CD&E WM is presented in table 4.1 below. The table shows the trend in research over the years as well as future direction or areas that need further researching. As can be seen from figure 4.1 the area of CD&E WM has not been fully exploited by researchers and this provides the opportunity to launch further studies into the area without repeating previous studies. None of the themes under review has been fully exploited in the literature. This review develops a framework for having an understanding of WM studies and how they the themes are interrelated.

# CONSTRUCTION, DEMOLITION AND EXCAVATION WASTE MANAGEMENT

Table 4. 1: Summary of CD&E waste Management Studies

Research Theme	Number of papers	(percentage) %	Type of Study	Method of Analyses		Country Most Researched	Trend in Research and Direction	Future Directions/further research
				Earlier	Recent			
C&D Waste Reduction	39	20.74	case studies surveys	Statistical analyses productivity rating multiple criteria analyses	critical success factors system dynamics models material flow analyses	UK HongKong USA Malaysia Portugal	exploring waste minimization and reuse options for the construction industry as well as factors that can affect the process	There is the need to further research the complexities of the waste management process to help increase understanding
C&D Waste Recycling	48	25.53	Survey Review Case Studies Experimental	Lab analyses	lab analyses Formative Scenario analyses	USA HongKong UK Brazil Australia	enhancing recycling of C&D waste to contribute to the management process through the establishment of the adequacy of recycled materials as replacement for natural materials	Creating a market for recycling through improved product performance and regulations and how to ensure sustainable recycling of C&D waste
C&D WM Practices on Sites	17	9.04	case studies surveys Reviews	statistical analyses Free flow mapping analyses	system dynamics Network based spatial material flow scenario building	HongKong	Evaluating and establishing best practices for the management of waste on constuction sites	Better understanding of site practices and ways of increasing their effectiveness
Economics of W Management	15	7.98	Case Studies Surveys	cost benefits analyses Statistical comparative analyses	statistical cost benefits analyses Use of Models	USA China Australia	measuring the cost and benefits of different waste management practices	extending the cost and benefit analyses to cover other benefits other than cost and how to improve practices to enhance level of benefits
C&D WM and Sustainability	12	6.38	case studies Surveys	life cycle impact assessment	factor analyses, life cycle impact analyses		setting the criteria for sustainable waste management and how to ensure sustainability in waste management	Improving the effectiveness of the Environmental, Social, and Economic effectiveness of waste management
C&D WM and the Environment	13	6.91	Experimental Surveys	Lab analyses	Process based life cycle analyses, Lab analyses	Denmark Spain USA Germany	detecting the effects waste production and its managemnt has on the environment and ways and means of overcoming the problems	increasing the environmental effectiveness of waste management through a clear understanding of the actual effects
C&D W Forecasting (Quantification)	17	9.04	surveys Review Case Studies	statistical analyses	material flow analyses Gray forecasting model Use of Softwares (iThink)	Hong Kong, USA, China	measuring and estimations of waste produced and expected from construction and demolition projects	Furthering the quantification of waste to enable benchmarking of different management performance will form the basis of waste management decisions or legislations
Human Factors in C&D WM	11	5.85	surveys Review	Statistical analyses	System dynamics logistics regression analytical hierarchy process	HongKong, UK Australia	Determing how actions of the people involved in waste management affect options and outcomes as well as what factors contributing to them	there is need to study how the attitudes and perceptions are formed and ways of influencing it positively to help the waste management agenda
C&D WM Legislations	16	8.51	Surveys Reviews	Evaluation, statistical analyses	Statistical analyses, Evaluation	UK	measuring the effect of legislations on waste management and its implications	How legislations should be tailored to encourage sustainable waste management and ways of ensuring compliance and effectiveness
Total	188	100.00						

## **4.5 FRAMEWORK FOR CD&E WM STUDIES**

This section develops a framework for understanding WM studies based on the themes created. Though many areas have been studied under the subject of CD&E WM, the complex nature of studies can be integrated into a model which will help with easy understanding of the research area. This analysis creates a link between the various WM themes to trace how studies in the field are interconnected. The complex study area of WM (WM themes) for the purpose of developing the framework are simplified into three main areas. These are people involved in WM (actors), drivers or reasons for embarking on WM (factors) and the actions undertaken in pursuing WM (actions/measures).

### **4.5.1 Waste Management Actors**

From the thematic analyses there are two main actors in CD&E WM and these are on one side the Contractors (including clients and designers) or firms and on the other hand the general public/advocates and governments. The first group is represented by contractors whereas government represents the latter. For these actors, contractors are more concerned with the management of waste for the economic benefits of it where as the main aim or driving force for the government is the protection of the environment with sustainability being a current/recent aim. Though not opposing, these two actors have different expectations or the priorities and these drive the efforts put in by the factor. Studies under WM actors covers attitudes, behaviours etc.

### **4.5.2 Waste Management Factors/Drivers**

As mentioned above, the CD&E WM factors are the forces that drive WM actions. Three main incentives or factors drive CD&E WM and these are economics, environment and sustainability. Though all factors affect all the actors in CD&E WM, their effects are to varying degrees. The factor with the highest effect on the contractor or client actors is economics as the main aim of firms is to maximise their profits. Therefore the main driver for WM is the economic incentive or gain that comes with it. Environment is a factor that drives the government actor and the need to protect human health and environment is the key driving forces for any WM actions taken by this factor. Over the years, the concept of



sustainability has led to strong concerns for governments, industry and the general public and this has led to the need to ensure all activities are done with the sustainable concept involved. This then adds the third factor which is sustainability to the factors/drivers affecting WM actions.

#### 4.5.3 Waste Management Measures/Actions

WM measures/actions are the third and most studied area of construction and demolition WM. This covers all the measures put in place to manage waste as well as the practices/actions performed. CD&E WM actions according to the literature are; waste quantification, waste reduction/avoidance, site WM practices, WM legislation and recycling. The WM measures are the actual management actions that are taken to ensure waste is managed. WM actions studied cover actions from various members within the construction supply chain such as; clients, designers and contractors (from management personnel to labourers/artisans).

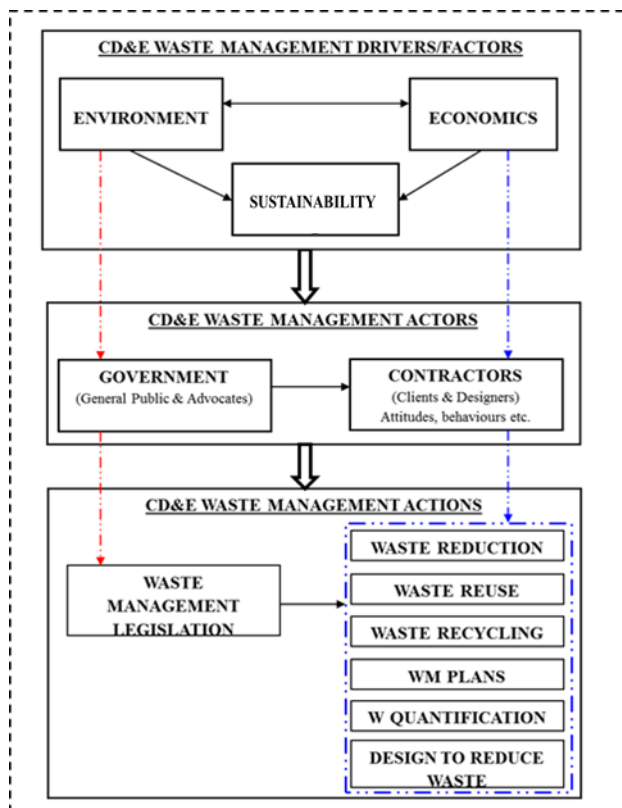


Figure 4. 2 Framework for Understanding CD&E Waste Management

Figure 4.2 above simplifies WM studies into a framework for easy understanding. This uses an action framework which groups the various CD&E WM studies into actions, outcome and actors showing the interrelation between the various themes in the field. This is to help paint a clearer picture of the CD&E WM study area and to help easily identify gaps or relationships which may be missing in the literature. From the picture painted, all CD&E WM studies are directed at contributing towards avoiding or reducing the amount of waste produced and proper management of what could not be avoided. It also shows the main aims of WM by the two actors in the field which are economic, environmental and sustainability concerns. The sophistication of recent studies point to the direction of ensuring sustainable management of waste from the construction industry and investigations have been directed at finding factors, ways and means of industry realising or reaching this goal.

The current literature on CD&E WM have been directed at ways of making the industry do even better with their WM. From the analyses of future directions of WM studies, it is evident that there are a lot more areas of CD&E WM which need to be studied further. A common area as pointed by the review done on studies in the area is studies into the effectiveness of WM practices in meeting the goals of WM (Yuan and Shen, 2011). This area, when well researched will help to provide a yardstick or benchmark for the making of improvements in CD&E WM practices.

### **4.6 SELECTED AREA OF RESEARCH AND GAP IDENTIFIED**

This study integrates three areas of CD&E WM for the purposes of filling the gap in knowledge identified. The requirements or goals for of WM as influenced by sustainable development and environmental management concerns and how they influence WM legislation; obligations set by WM legislation to achieve the goals of the WM concept and the practices of construction firms in meeting the obligations of WM legislation.

The concerns leading to the developing of CD&E WM legislation can clearly be seen as that of environmental management and sustainable development. In the area of environmental management and sustainable development, the concerns are:

- how to prevent or reduce the amounts of waste generated from harming/polluting health and the environment;
- to ensure sustainable use of resources and reduce over reliance on depleting natural resources; and
- lack of space for waste landfilling and the need to find alternative final destinations for waste materials

Three areas of study in CD&E WM will be combined into an integrated study to make a contribution to the field. A look at the literature suggests that WM Legislation is a critical factor for ensuring CD&E W is well managed. It is also advocated that the attitudes of industry players must be taken into account as this to a large extent affects efforts towards WM (Teo and Loosemore, 2001). There appears to be a connection between the need for WM legislation and attitudes as legislation from the literature is known to affect people's attitudes towards certain actions.

Compliance with waste legislation comes with it actions or activities to be undertaken by the firms being regulated and regulations are generally seen as a burden on industry as it takes time and resources which could have been channelled into other use. The literature is however not well developed on the adequacy of WM legislation in terms of the obligations put on the construction industry as well as the adequacy of the measures put in place by the construction firms to meet these obligations and how well they contribute to CD&E WM.

With legislation being a critical factor in CD&E WM, a study into the adequacy of legislation in the UK that targets the management of waste in the construction industry and the adequacy of measures put forward by the firms will go a long way in contributing to the study area by way of recommendations for proper WM practices.

In studying the effectiveness of WM practices or actions, this by researching into how to enhance CD&E WM, CD&E WM legislation is regarded a critical factor for ensuring waste reduction and management according to many studies. Different studies on the different themes have shown that legislation influences WM factors in one way or another i.e. through setting targets for management options, impacting the behaviour of the human factors in WM, creating a market for the use of recycled materials, setting high landfill charges to discourage disposal etc. Douglass and Pratkanis (1994) found that the effect of

legislation upon people's attitudes is relatively weak and according to Teo and Loosemore (2001) it often helps if the legislation is accompanied by incentives to adopt it. No research has been conducted integrating legislative influence on the various factors (covering all the themes in in CD&E WM) and to what level economic incentives should be used.

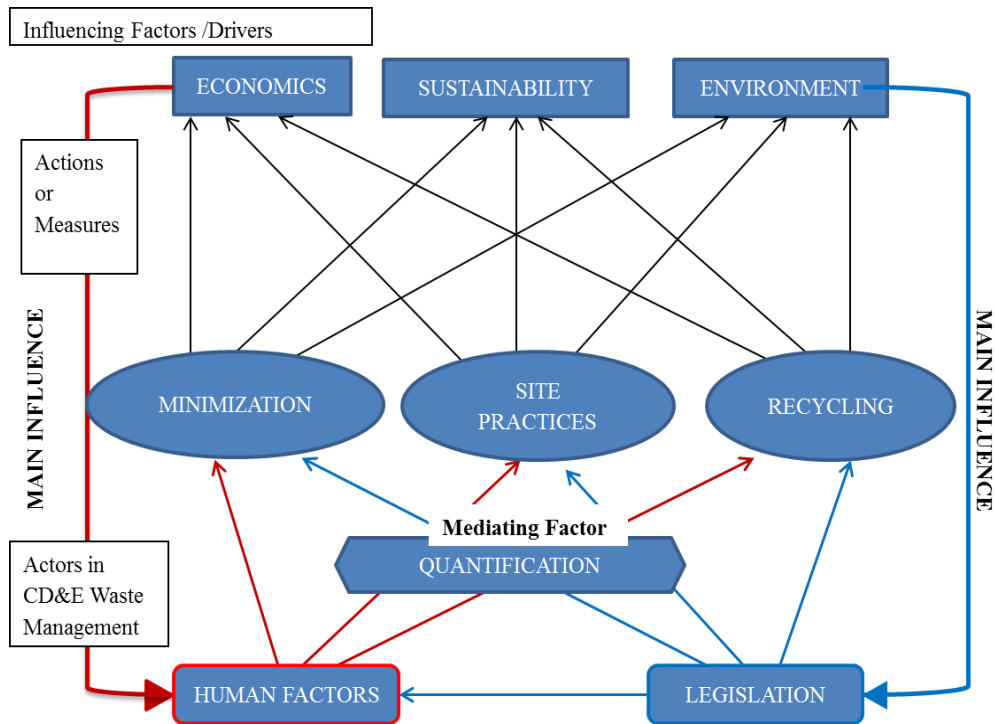


Figure 4. 3 Integrating CD&E WM studies

## **4.7 CHAPTER SUMMARY**

This chapter has reviewed literature on CD&E WM. A synthesis of the literature review suggests a common trend towards sustainable management of CD&E waste. Throughout the review, emphasis has been placed on the relationship between CD&E WM and the concept of sustainable development. This formed the basis for identifying the knowledge gap to be filled by this research. As presented in the chapter, all CD&E WM studies can be grouped around common themes such as: waste reduction; waste recycling; practices on construction sites; WM and sustainability; human factors in WM; and WM legislation. The chapter also reviewed the methodologies adopted by various CD&E WM researchers. At the end of the chapter, a framework is built which seeks to integrate all issues regarding CD&E WM to build a better understanding of the subject.

The next chapter develops a conceptual framework which serves as a guide the remainder of the research.

## CHAPTER FIVE

### THE CONCEPTUAL FRAMEWORK

#### 5.1 INTRODUCTION

To answer the research questions requires an understanding of the interrelation between the expected outcomes of CD&E WM (WM) legislation and policy and CD&E WM practices. From the analyses conducted in the previous chapters, there is an indication that CD&E WM encompasses a lot more than just WM legislation. Understanding of the various aspects of CD&E WM is therefore needed to develop a framework connecting the various aspects and concepts within CD&E WM and map them unto a measuring framework to pursue the aim of the research. This section analyses the intended goals of CD&E WM legislation and the outcomes of CD&E WM practices and the conceptualised connection between them. Based on these factors, a means of measurement is developed which will be used to determine the extent to which CD&E WM practices meet the goals/expected outcomes of CD&E WM legislation. A conceptual framework that links these elements is developed and explained in this section.

#### 5.2 CONCEPTUAL FRAMEWORKS

According to Sinclair (2007), the development of a theoretical or conceptual framework forms an integral part of a research as it forms the basis for analysing the interrelations among concepts and relates to the search for theoretical understanding and its translation into meaningful practice. Having considered knowledge outcomes from the literature carefully, permutations or links between the outcomes can be projected and predictions made on how relationships might impact on outcomes. This search for theoretical understanding or links between concepts and its translation into meaningful practice is what is done when developing a theoretical or conceptual research framework. As defined by Miles and Huberman (1994 page. 18), a conceptual framework is a visual or written product that

“explains, graphically or in narrative form, the main things to be studied, the key factors, concepts, or variables, and the presumed relationships among them”.

Research is a journey toward an endpoint – to develop new knowledge that will contribute to practice – and a theoretical/ conceptual (map) framework is a guide through this journey. Like planning a journey to an unfamiliar country, one needs to seek as much knowledge as possible about the best way to travel, using previous experience and the accounts of others who have been on similar trips. ‘Survival advice’ and ‘top tips’ enable them to ascertain the abilities, expectations and equipment that may help them to have a successful journey with good outcomes, to achieve their objectives and return to base safely (Sinclair, 2007).

Just as in the journey example above, the development of a conceptual framework requires seeking enough information (knowledge) as possible about the phenomena to be studied, about the various concepts and factors as well as the known and or presumed relationships among them. Like the accounts of other people who have had similar journeys, existing theories or models from the literature are relied upon in developing a conceptual framework. The main things to be studied in this research are: WM legislation and its intended goals; the translation of the requirements of WM legislation into practice; WM policies of construction firms; attitudes and behaviours in construction and demolition WM; WM practices of construction firms and their outcomes. Building a conceptual framework for this research requires knowledge about the various concepts and subjects listed above. The discussion below reviews literature on the subjects and the concepts and the presumed relationships between them are discussed below.

### **5.3 A CONCEPTUAL FRAMEWORK FOR WM LEGISLATION AND OUTCOMES**

Majority of the research on environmental legislation and firms tend to study compliance behaviour (decisions) of firms and measures to achieve/increase compliance (See for example Mitchell, 1996; Zaelke *et al*, 2005; Burbey and Paterson, 2005; Foorthuis and Bos, 2011).

Foorthuis and Bos (2011) review literature on compliance and develop a framework for characterising and categorizing compliance management tactics. Burbey and Paterson (2005) test two theories on improving compliance and conclude that, for regulations where the cost of compliance exceeds benefits, deterrence is the best form of enforcement. The study by Zaelke et al (2005) focuses on how to make the law work by looking at how compliance decisions contribute to sustainable development. Heyes (1998) surveys literature on environmental legislation and compliance and concludes that rates of compliance with many of the most important environmental legislation in the USA, EU and elsewhere are low. Theories on decision-making posit that people and groups select among alternative lines of action in a limited number of relatively simple and universal ways (see James and March, 1994). According to Suchman (1977), these ways of decision making can be divided into three leading perspectives – rational/instrumental, normative/moral and cognitive/constitutive/definitional and these translate into behaviour (See Suchman, 1997). Whereas rationalistic perspectives analyse decision making as based on pure material self-interest, normative perspectives hold that decision making is primarily on the basis of ingrained moral beliefs, with cognitive perspectives analysing decision-making as primarily on the basis of ‘taken-for-granted’ roles and scripts, without consciously exploring alternative possibilities at all (Suchman, 1997).

In the area of compliance behaviour of firms however, compliance diverges into two basic perspectives; instrumental (rationalist) and normative (moral) perspectives (See Foorthuis and Bos, 2011). Rationalistic models of behaviour focus on the actor’s calculation of costs and benefits in deciding on whether or not to comply with environmental regulation. According to the theory of rational crime (Becker, 1996), a profit maximizing firm will comply with environmental regulation only as long as the expected penalty for non-compliance exceeds the cost of compliance and there is high likelihood of noncompliance being detected (See Becker, 1968). From this end, the major enforcement approaches proposed to ensure compliance are command and control tactics (to punish offenders and rewards for compliant firms). Normative models on the other hand depict that compliance behaviour is not solely determined by cost and benefit analysis (See Sutinen and Kuperan, 1999). From this perspective, firms are moral i.e., believe in the legitimacy of laws and are



willing to comply. Normative models focus on cooperation and assistance as stimulating compliance with legislation by increasing the capacity of firms to comply. This generally takes the form of providing support and encouraging shared discourse to make rules clearer, more persuasive and easier to comply (Foorthuis and Bos, 2011).

According to Mitchell (1996) however, compliance in itself does not necessarily denote that the goals of legislation are being met. Unlike majority of the studies on legislation and firms which tend to focus on how best to achieve compliance, this research goes beyond achieving compliance to investigate the extent to which current CD&E WM practices (compliance efforts) meet the expected outcomes of regulation. As shown in figure (5.1), the conceptual framework developed here seeks to find the relationship between outcomes of CD&E WM practices and the expected outcomes of CD&E WM legislation.

## 5.4 FRAMEWORK DEVELOPMENT

In developing the conceptual framework, the following elements are analysed for determining how practices of firms meet the intended outcomes of WM legislation:

- relevant regulations affecting the management of construction and demolition waste and what the regulations expect of the firms so far as construction and demolition waste is concerned;
- intended outcomes of legislation. The goals waste legislation seeks to achieve by the obligations given to waste producers;
- influences on the decision making of firms in relation to WM practices;
- practices construction firms undertake to manage their waste; and
- the actual outcomes of WM practices.

A general overview of the conceptual framework is shown in figure 5.1 below. To provide some theoretical rigour and conceptual clarity to the constituent elements, a concept analysis of each of the elements is discussed below.

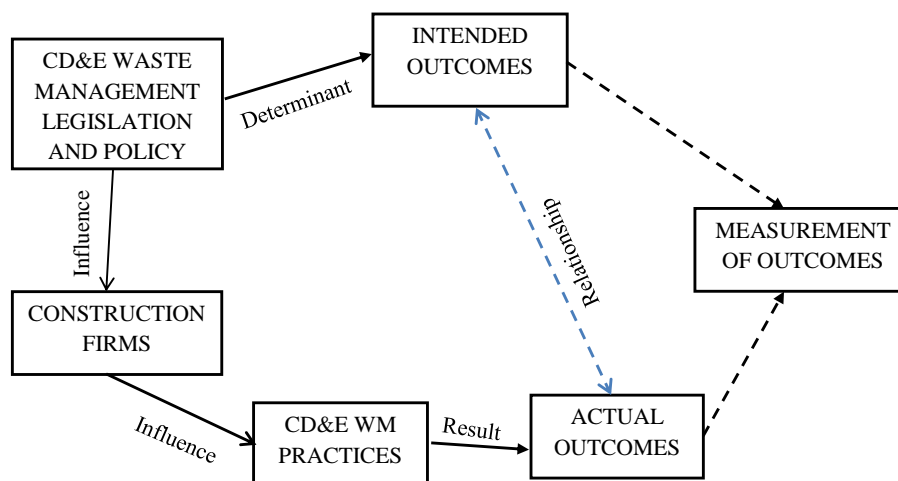


Figure 5. 1: General overview of the Conceptual Framework

### 5.4.1 WM Legislation and requirements

As discussed in Chapter 2, WM legislation and policy favour environmental management and sustainable development which arose out of the need to control the destruction of the environment and misuse of natural resources (See Chapter 2.3). The concepts of Sustainable development and environmental management are directed at preventing the pollution of the environment (with its negative effect on life) and ensuring resource security is achieved (see Chapter 2.3). In the UK, waste legislation is derived from the EU regulatory framework and as such current legislation is mainly directed at implementing EU Directives (Jordan, 2006). Chapter three discusses the relevant legislation affecting the management of CD&E waste in the UK. A general overview of this is given in figure 3.1 in chapter 3.4.3. The relevant UK legislation affecting CD&E WM are the:

- Landfill (England and Wales) Regulation
- Environmental permitting Regulation
- Environmental protection duty of care Regulation
- WM licencing Regulation
- Site WM plans Regulation
- Waste (England and Wales) regulation

To achieve the intended outcomes of WM legislation and policy, the Waste (England and Wales) Regulations 2011 implements the waste hierarchy (WH) requirement of the WFD. The WH requires waste producers to manage waste based on the most sustainable option. As detailed in figure 3.2, the waste hierarchy requires firms to manage waste focussing on prevention/reduction of waste, preparing for reuse, recycling, recovering through energy recovery and other methods with disposal being the least desirable resort (See Chapter 3.5.2). By this, CD&E WM legislation requires construction firms to tie their actions/practices to the requirements of the waste hierarchy.

#### **5.4.2 Intended outcomes of CD&E WM legislation**

As discussed in chapter 3, the overall goal of WM legislation can be linked to sustainable development - to ensure prevention of the pollution of the environment and health from waste generation (See Chapter 3.3.1) and to ensure efficient allocation of natural resources. UK WM legislation has a target to reduce waste by recycling 70% of CD&E waste by the year 2012 and ensure no CD&E waste is sent to the landfill by 2020 (EU Commission, 2008). These targets are to be achieved with the help of the waste hierarchy (See Chapter 3.5.2). According to the EU WFD, the overarching legislation for WM, the goals and intended outcomes of all CD&E WM legislation can be summarised as:

1. reduction in the total volume of waste generated;
2. managing waste without harming the environment and health (reduction in pollution);
3. reduction in the use of natural raw materials;
4. reduction in the amount of land space used for waste landfilling; and
5. ensuring economic management of waste.

#### **5.4.3 WM Decision making (Behaviour)**

The mechanism for decision making of firms is based on a number of factors (Suchman, 1997; Foorthuis and Bos, 2011). Studies investigating the determinants of firm decision making are of two schools. From one school of thought, firms are profit maximising entities and this drives all decisions and activities (firm behaviour). The second school of thought sees firms as normative in their actions. From this angle, decision making goes beyond

traditional cost benefit analysis as it involves many other considerations. In relation to pro-environmental behaviour (environmental significant behaviour), defined as behaviour that consciously seeks to minimize the negative impact of one's actions on the natural and built world (minimize resource and energy consumption, use of non-toxic substances and reduce waste production) (Stern, 2000; Kollmuss and Agyeman, 2002), firm decisions are said to be based on a number of socially determined factors in addition to economic considerations (Schwartz, 1977; Ajzen, 1993; Stern *et al.*, 1999).

Studies analysing the behaviour of firms in relation to the environment (pro-environmental practices) are based on two broad perspectives (Chen, 2005). From the business management and strategy literature, structural and organizational components of firms determine the behaviours of managers and decision makers which translate into firm behaviour (See Cyert and Williams, 1993). Studies from the behavioural sciences, psychology and sociology emphasize that behaviour is determined by internal drivers of human action and socially determined factors (See Schwartz, 1977; Ajzen, 1993; Stern *et al.*, 1999). A general consensus of firm decision making is that, it occurs at the institutional or organizational level which contains the policy makers of the firm (Foorthuis and Bos, 2011). Though Jennings and Zandbergen (1995) argue that external pressures from regulations and regulatory enforcement are the main impetus of environmental management practices of firms (Jennings and Zandbergen 1995 in Delmas and Toffel, 2004), studies by Scot (1992) and Toms (2002) report that, there are internal and other external factors that affect the decision by firms to undertake environmental significant practices/activities (example WM).

According to Scot (1992), factors known to affect policy decisions of firms are pressure from external bodies in the form of legislation and industrial best practices and resource availability (Scott, 1992). Scot's assertion is in line with views from the institutional theory which suggest that, a firm's decisions to adopt specific practices are affected to a large degree by regulatory, cognitive and normative factors (Delmas and Toffel, 2004). The considerations affecting the decision to pursue WM by construction firms can easily be analysed based on the internal and external factors (drivers). Internal factors relate to factors based solely on the internal considerations of the firm and these are resource considerations (availability) and

economic considerations. The external factors relate to external pressures in the form of regulatory requirements and social pressures.

#### **5.4.3.1 Internal drivers of waste management decision making**

As mention above, the decision to adopt or engage in particular WM practices by firms is determined in one part by internal drivers prevalent in the firm. These internal drivers are in the form of economic considerations and resource availability.

##### ***5.4.3.1.1 Economic considerations***

Construction firms, like all other business ventures are regarded as rational entities; their decisions to embark on particular activities are affected to a large extent by economic considerations. This is because firms are generally motivated to pursue practices that are likely to benefit them more by increasing their profitability. Costs are the key determinant of decisions and choices in WM technologies and practices (Mills et al., 1999; Poon et al., 2001; Chen et al., 2002; Wang et al., 2002). In the absence of legislation, construction firms are said to pursue WM purely for economic gains (Poon et al., 2001; Chen *et al.*, 2002; Wang *et al.*, 2002). CD&E WM according to the literature promises profitable returns by way of a reduction in the quantities of materials purchased due to reduced waste production and a reduction in the cost of transporting and disposing waste (Shen and Tam, 2002). It is assumed therefore that the internal desire to increase profitability will drive firms to manage their construction and demolition waste and this will have a great bearing on the WM practices of construction firms.

##### ***5.4.3.1.2 Resource availability***

Aside the economic considerations driving the decisions of firms, another internal driver that affects what actually gets done by firms is the availability of resources. It is argued that, the ability to adopt and commit resources towards environmental action is determined to a large extent by the resources available to the firm (Chen, 2005). Regardless of a firm's intentions or attitudes towards environmental action, the availability of resources to the firm will be the

actual determinant of environmental action/practices. Empirical evidence suggests that larger firms stand advantaged regarding committing resources to environmental activities. In the area of construction and demolition WM, due to the large resource demands for WM, it is expected that resource availability will play a major role in decision making. The larger the firm size, the higher the likelihood to commit more resources towards environmental policy and vice versa (Chen, 2005).

#### **5.4.3.2 External Drivers of waste management decision making**

Aside the internal drivers of firm environmental significant actions, there are external drivers that drive firms to contribute resources to WM practices. Aside the external pressure from legislation which legally requires firms to manage waste, there are external pressures from social bodies which also affect WM decisions.

##### **5.4.3.2.1 Social Pressures**

According to Scott (1992), a firm's practices and structures are influenced by social and cultural pressures imposed on the firm. Toms (2002) reports that, aside internal pressures, there are external social pressures which require firms to pursue positive environmentally driven programs especially when operating in more environmentally sensitive sectors. With public knowledge on the negative influence of the construction industry on the environment, through the production of waste and the misuse of natural resources, firms are pressurised into undertaking environmentally significant actions which will ensure a reduction in the negative influences their activities have on the environment. A major external factor affecting a firm's environmental behaviour is pressures exerted by public opinion (Bartolomeo, 1995). These social pressures from public opinion are known to be effective in environmental sensitive climates. Presently, there is greater awareness of the need for sustainable development and this makes the issue of WM very vital both to governments and society at large. In developed economies like the UK where information is readily available to the local public, firms are pressurized to ensure they have a good reputation in the public eyes due to social concerns.

These social concerns have the ability to affect the share of a firm in a well-informed market where competition for market share is high. Empirical research suggests that improving the firm's reputation creates goodwill and ultimately has a positive effect on market value (Chauvin and Hirschey, 1994; Fombrun, 1996 in Toms, 2002). To maintain the reputation of firm and earn the respect and approval of 'relevant others', which leads to increased market share, firms are pressurized to exhibit positive environmental behaviour (May, 2004). Social pressures are therefore expected to have a high impact on the WM decision making of construction firms. Welford (1995) reports that, pressures from regulation as well as public opinion can be linked to an increase in the considerations firms give to their environmental performance and in particular their impact on 'the state of the environment' (Welford 1995 in Azzone et al, 1996).

#### ***5.4.3.2.2 Regulatory requirements***

From a list of factors promoting sustainable WM, regulatory requirements are said to be the most effective (Osmani, Glass and Price, 2008; Jallion and Poon, 2008; Lu and Yuan, 2010; Wang et al., 2010). Review of literature on WM reveals that, in the absence of regulatory requirements, construction firms will pursue WM purely based on economic reasons. This makes legislation very vital in ensuring waste is managed with the environment as a beneficiary. Fear of formal and informal sanctions by regulators and the internalization of legal norms or moral commitment to comply with the law has a great bearing on managerial decision making regarding environmental compliance (Vandenberg, 2003).

From these perspectives on firm behaviour, it can be argued that social pressures, regulatory requirements, economic incentives and resource availability are the main considerations of firms in relation to WM decision making. These factors affect a firm's behaviour by influencing the policies of firms. Azzone *et al.* (1996) suggest that, environmental policy is a useful indication of a firm's (attitude towards) pro-environmental behaviour and making environmental policy a useful determinant of WM behaviour. Foorthuis and Bos (2011) define policy as a set of norms requiring a particular behaviour whereas norms are defined as 'social attitudes of approval and disapproval, specifying what ought to be done and what ought not to be done (Sunstein, 1996). A firm's environmental policy (WM policy), defined

as the set of aims and goals of the firm in relation to the environment, is a good measure of the attitude of the firm towards environmental management and WM specifically. In making an environmental or WM policy, Brophy (1995), after a review UK environmental policy concludes that an ideal environmental policy should include waste minimization, legislative compliance and assessment of environmental performance.

WM policy is theorised to be the main input influencing CD&E WM practices of firms and this is determined to a large extent by regulatory requirements, social pressures, economic incentives and resource availability. This relationship is presented in figure 5.2 below.

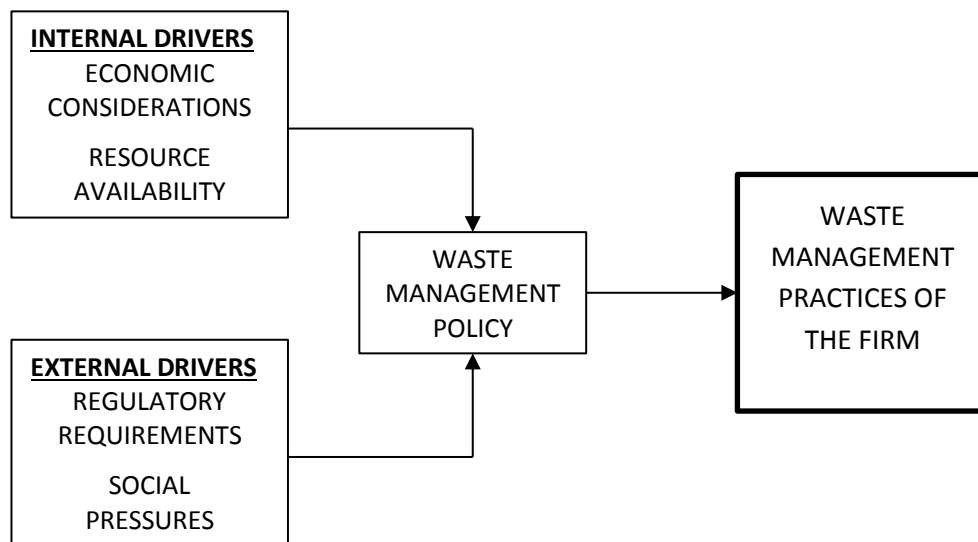


Figure 5. 2 Determinants of CD&E waste management practices

As presented in figure 5.2, a firm's WM practices are influenced to a large degree by waste policy. However, a firm's ability to commit resources to WM practices is dependent to a large extent on the size of the firm. According to Chen (2005), larger firms are generally seen to have a higher potential to commit resources to environmental policies or WM policies. This is because larger firms generally will have enough resources and time at their disposal. Chen however goes on to add that, though larger firms have higher potential, it does not always reflect in WM behaviour as other activities might get in the way of actual WM practices.



### 5.4.3 CD&E WM Practices

According to the review of literature on CD&E WM, there are many practices aimed at managing waste. These practices range from activities towards waste prevention to the final disposal of waste. From the review, WM practices of construction firms can be generally grouped under the following headings: waste quantification/ forecasting, early planning activities, site WM techniques/plans, material handling, waste source separation, waste reuse, recycling, recovery and disposal. As discussed in chapter 4, WM practices are aimed at either preventing the generation of waste or managing the waste produced to ensure it does not harm the environment, or health. These practices include: design to eliminate or reduce waste; adoption of low waste technologies; waste quantification; early planning activities; material handling practices; the use of WM contractors; waste reuse; recycling;; recover and landfilling. A summary of WM practices is provided below (See Chapter 4.3 for details).

Figure 5.3 below shows a summary of practices of construction firms towards the management of CD&E waste.

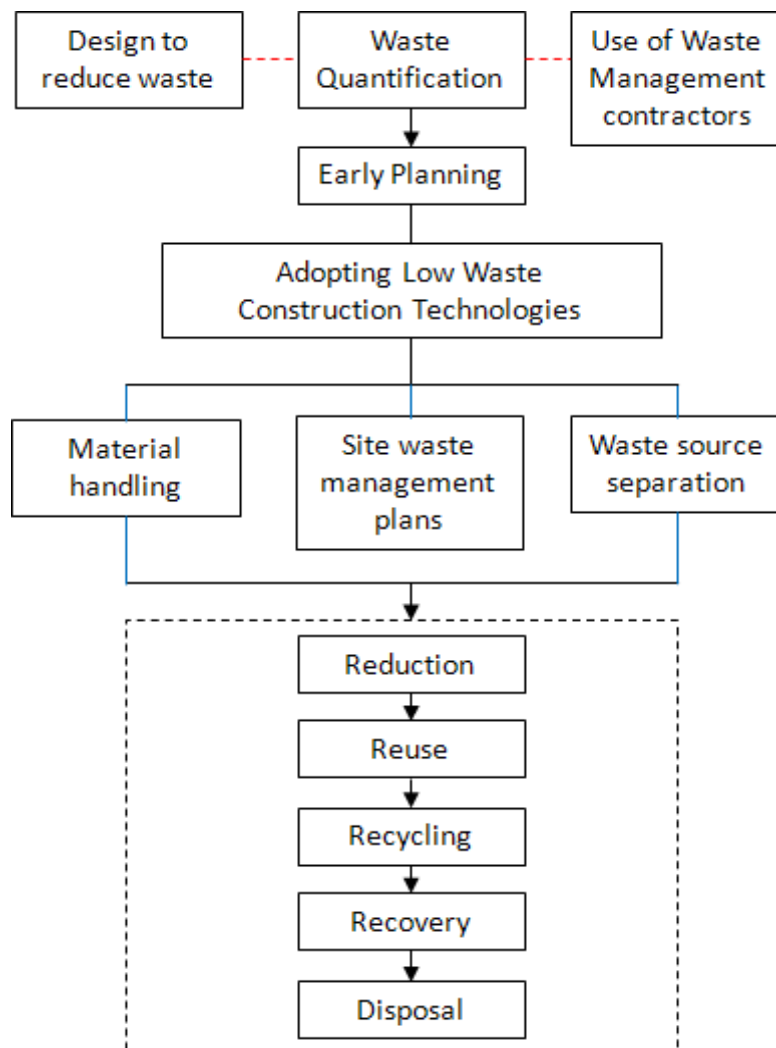


Figure 5. 3: CD&amp;E WM practices

#### 5.4.4 Outcomes of WM Practices

As discussed in chapter 2, the concept of WM is to ensure a reduction in the scope of waste harming the environment (Strange, 2002). From the WM literature, sustainably managing waste contributes to all three aspects of sustainable development; economic, environmental and social (Klan, Vikman and Brattebo, 2003). This means CD&E WM needs to be environmentally effective, economically affordable and socially acceptable (Nilsson-Djerf and McDougall 2000; Morrissey and Browne, 2004). These requirements of WM practices are expected to ‘undo’ the negative impacts of waste generation on the environment, health and the cost of construction projects. Sustainably managing waste results in resource conservation, cost savings and waste/ pollution reduction (Chang and Lo, 2003; Dosho,

2008). The outcomes of CD&E WM are summarised in figure 5.4 below (See Chapter 2.6 for details).

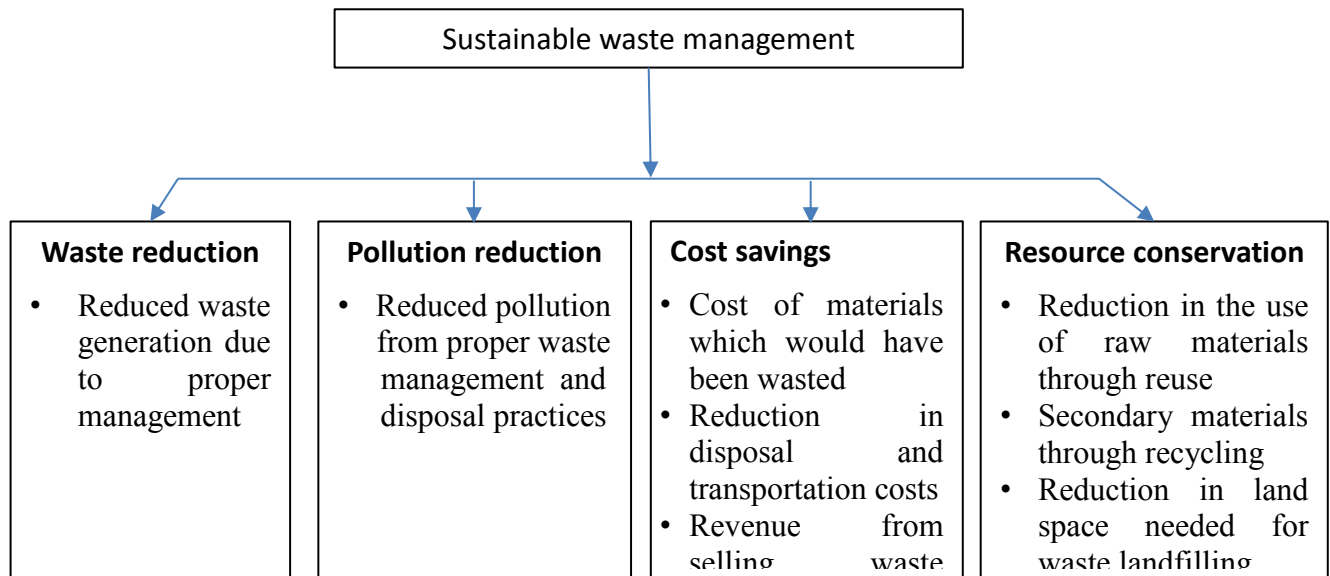


Figure 5. 4 Outcomes of CD&E WM practices

## 5.5 MEASURING THE EXTENT TO WHICH CD&E WM PRACTICES MEET THE INTENDED OUTCOMES OF WM LEGISLATION, A CONCEPTUAL ANALYSIS

To measure the extent to which CD&E WM practices meet the intended outcomes of waste legislation in the UK, the following relationships are hypothesized based on the analyses made in the preceding section. As shown in the review of the various regulatory instruments affecting the management of CD&E waste in the UK in chapter 5.4.1, waste legislation in the UK aims to achieve the protection of health and the environment and also to ensure cost effective management of waste is achieved. The waste hierarchy (figure 3.5.2) is accepted as the most sustainable means to manage waste and based on this; waste legislation requires

firms to manage waste according to the order of the waste hierarchy. Through the waste hierarchy directives, WM legislation seek to achieve the regulatory intended outcomes of: reducing the total volume of waste; reducing the level of pollution due to waste; conserving natural resources through reduction in the use of natural raw materials; reducing space requirements for landfilling and ensuring WM options are pursued economically.

On the other hand, the motivations for construction firms to manage their waste are not just regulatory requirements but encompass other considerations. From figure 5.2, a number of internal considerations as well as external considerations including legislative requirements form the motivations for firm WM practices. These considerations, economic, resource, regulatory requirements and social pressures, are conceptualised to result in waste policy which determines the WM practices of construction firms. Studies on CD&E WM practices shows there are various practices embarked on by firms which cover quantification to disposal activities. As demonstrated through the review of literature on WM practices (See chapter 4.3), firms embark on WM for a number of reasons with economic gains being the highest of motivations. Shown in figure 5.4, outcomes of sustainable WM encompass waste and pollution prevention, cost savings and resource conservation which relate to the intended outcomes of WM legislation.

To achieve the aim of this research, the practices of construction firms are measured against the requirements of the waste hierarchy whereas outcomes (actual) of WM practices are measured against the intended outcomes of WM legislation to determine the level to which firms meet the expectations of the legislation. The resulting conceptual framework is shown in figure 5.5.

## THE CONCEPTUAL FRAMEWORK

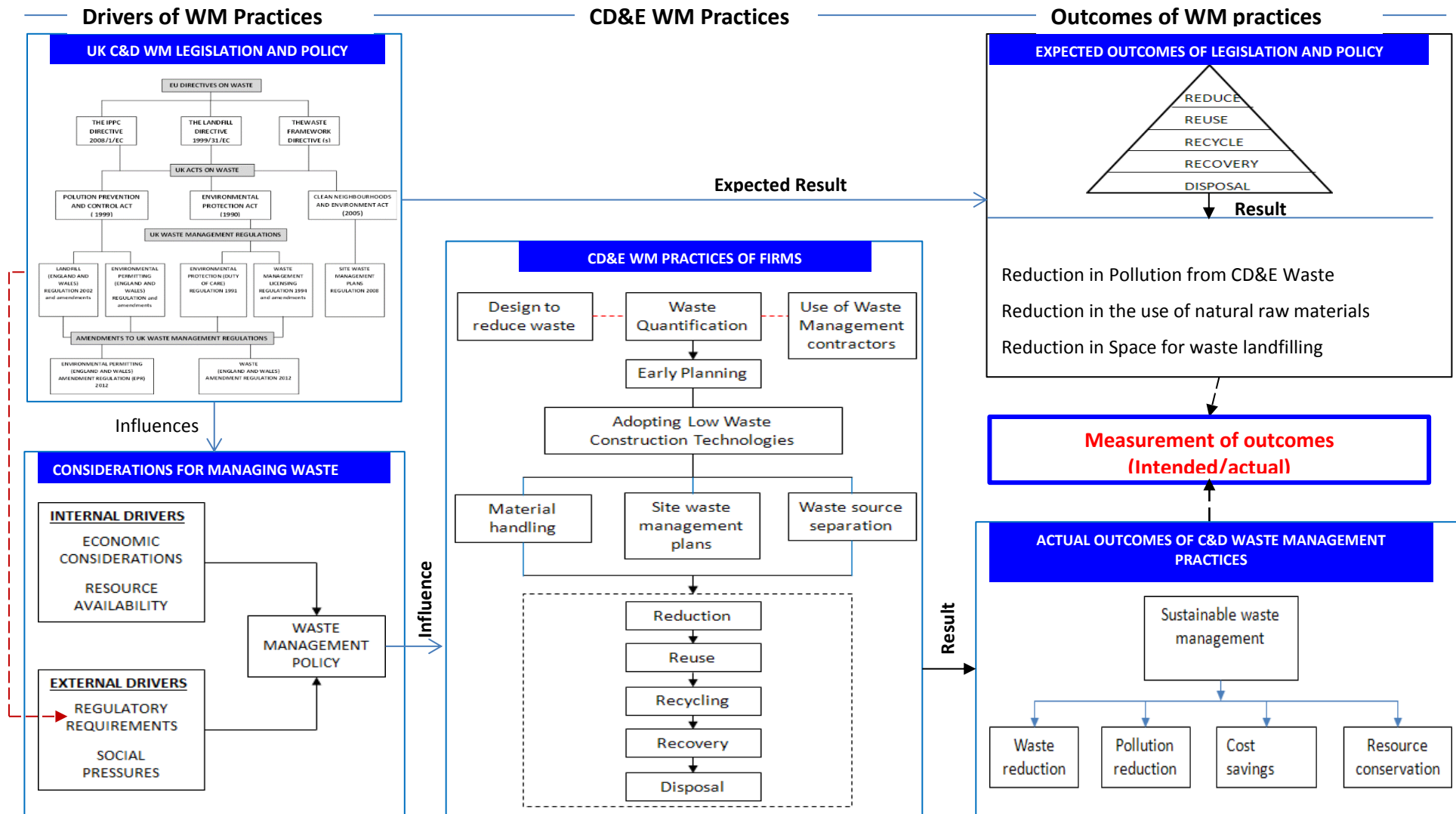


Figure 5. 6 A Conceptual framework for measuring the extent to which CD&E WM practices meet intended outcomes of legislation

## **5.6 OPERATIONALIZATION OF THE FRAMEWORK**

The framework developed above gives a conceptual understanding of the issues being studied and the assumed relationships between them. This section describes how data will be collected for the various concepts and factors in the framework.

### **5.6.1 Measuring the intended outcomes of WM legislation**

As discussed in section 3.5, the intended goal of WM legislation is to result in sustainable WM. The components of sustainable WM which are: waste reduction; pollution reduction; resource conservation; and cost savings. These components form the basis for the intended outcome of WM legislation and will form the basis for measuring the performance of construction companies.

### **5.6.2 Identifying the considerations and practices of construction firms**

As shown in the framework, a number of drivers are responsible for the practices of construction firms towards WM. For this research to make meaningful contributions to CD&E WM of construction firms, it is necessary to collect data on the drivers of WM within the companies to determine the role WM legislation plays in the process. This will also help to identify other drivers responsible for WM which may not be captured in the conceptual framework. In addition to the drivers, the WM practices of construction firms must be investigated to help fully understand what outcomes the firms achieve from these practices.

### **5.6.3 Measuring the outcome of CD&E WM practices**

The sustainability criteria for WM will be used as a measure for determining the outcome of WM practices (Tammemagi, 1999; Chong and Lo, 2003). Practices will be measured on how they contribute to waste reduction, pollution reduction, resource conservation and cost savings. Measurement will be based on the extent to which practice led to waste reduction, reuse, and recycling.

Contribution to waste reduction will be measured based on the amount of waste that is prevented from occurring in the first instance, and how much of the generated waste is reused, recycled, or recovered (prevented from ending up in landfills). Pollution due to

waste is dependent to a large extent on the amount of waste produced, the quality of the waste (composition), the mode of management and disposal (Trankler *et al.*, 1996; Strange, 2002; Begum *et al.*, 2009). Contribution to pollution prevention will be measured based on the reduction in volumes of waste generation, the segregation of the waste, the proper management of waste and the proper disposal of waste (landfill).

Contribution to resource conservation by managing waste will be measured in relation to the reduction in the purchase of excessive raw materials which get wasted. Reducing the amount of materials used can be achieved in three ways: reducing the quantities of raw materials purchased due to proper material management leading to reduced wastage rates; reuse of materials in the waste; substituting raw materials for recycled materials. Land space requirements for waste landfilling is directly proportional to the quantities of waste landfilled. Contribution to reduction in space requirement for landfilling will be measured based on the reductions in the amount of waste going to landfill due to WM activities.

Cost savings from WM will be measured based on: the reduction in wastage rates and reuse of waste materials; reductions in cost of transporting and disposing waste at landfills; and revenue from selling materials from waste.

## 5.7 CHAPTER SUMMARY

This chapter has developed a conceptual framework to aid in the collection of data to fulfil the research aim of investigating the extent to which WM in the construction industry meets the intended outcomes of government legislation and policy. As evidenced in the chapter, there is the need to investigate the factors that drive construction firms to manage waste, and the practices embarked on during the WM process. These two investigations will help to map the outcomes of WM to the practices of firms making it a good basis to determine how adequate the practices are in meeting the intended outcomes of government legislation. The chapter has also shown that the intended outcome of government legislation is to ensure sustainable WM which entails resource conservation, pollution prevention, waste recovery (through reuse, and recycling), reduction in the take up of landfill space, and economic management of waste. WM practices of construction firms will therefore be measured based on the extent to which they result in pollution prevention,

resource conservation, waste recovery (diversion from landfill), and the economic management of waste.

The next chapter discusses and justifies the research design adopted



## CHAPTER SIX

### RESEARCH METHODOLOGY

#### 6.1 INTRODUCTION

Following the conceptual framework developed in the previous chapter, this chapter discusses the research design and outlines the methodology adopted for determining the extent to which WM practices of UK firms meet the intended goals of legislation and policy directives. An essential aspect of scientific research is deciding how to conduct a research; the most appropriate way to collect the data and how to analyse the data collected to ensure the aims of the research are met. This chapter justifies the choice of data collection method adopted and presents arguments for the method of analysis used (the research design).

#### 6.2 RESEARCH DESIGN

Yin (2014), defines research design as the logical sequence that connects the empirical data of a study to its initial research questions and, ultimately, to its conclusions. For Bryman and Bell (2003 p.32), research design provides a framework for undertaking the research and relates to the means for collecting and analysing the data to answer the research questions posed. Denzin and Lincoln suggest that, a research design sets out guidelines that link together the elements of methodology adopted for a study; relating the paradigm to the research strategy and then the strategy to the methods for collecting empirical data (Denzin and Lincoln, 2000 in Gamage, 2011). Review of the various definitions suggests that research design is a crucial aspect of the whole research process. Research design can simply be seen as the piece of the research that makes the research puzzle complete by connecting the other pieces of the research (research questions and results) into a single unit. Due to the role played by the research design, it can be argued that the stronger or the more befitting the research design, the better the final piece.

The choice of research design is affected by a number of considerations, notably among them are the nature of the research being undertaken, and the type of questions it seeks to

address. These considerations are to ensure the problem of gathering evidence that does not address the initial research questions is prevented (Yin, 2013). Saunders *et al.* (2007), argue that the choice of research strategy/design is determined by: the research question(s); objectives; the philosophical underpinnings or research paradigm; the extent of existing knowledge; and the amount of time and other resources available. The following section discusses research paradigms and makes a claim for the paradigm chosen for this research.

### **6.1.1 Paradigm for investigating waste management practices in the UK construction industry**

As mentioned above, the research paradigm has a major influence on the design of any research as it has practical implications for conducting the research (Saunders *et al.*, 2011). According to Creswell (2009), a paradigm may refer to a philosophical worldview which represents a basic set of beliefs that guide human action. Corbin and Straus (2008), define the paradigm/philosophical orientation as ‘a worldview that underlies and informs methodology and methods’. Other researchers like Pollack (2007) define paradigm as a ‘commonly shared set of assumptions, values and concepts within a community which constitutes a way of viewing reality’. Review of research paradigms or philosophical worldviews suggest that the world view forms the basis for the methodology adopted for a research and at the same time affects the methods used for the collection and analysis of data. Fellows and Liu (2008), state that, paradigms operate not only to determine what views are adopted but also the approach to questioning and discovery.

Paradigms in research are of two traditional perspectives: the positivism; and the interpretivism paradigms which are both based on different stances of ontology, epistemology and axiology (Baily, 1987; Walliman, 2001; Fellows and Liu, 2008). Ontology refers to the nature of reality (Tan, 2002; Creswell, 2007; Fellows and Liu, 2008) whereas epistemology is “the theory or science of the method or ground of knowledge” (Blaikie, 1993, p.6), and refers to how the researcher knows reality (Tan, 2002). Axiology (the branch of philosophy that studies judgements about value (Saunders *et al.*, 2007)) in research, refers to the role of values in research and involves values, ethics, and belief systems of a philosophy as well as assumptions about the value that the researcher attaches to the knowledge (Creswell, 2007).

In talking of philosophical views or positions in research, Nagel suggests that the scientist adopts a ‘view from nowhere’ which implies the possibility of total objectivity and that phenomenon exist totally independent of any observer (Nagel, 1986 in Fellows and Liu, 2008). Unlike Nagel, Kuhn notes that ‘what a man sees depends both upon what he looks at and also upon what his previous visual-conceptual experience has taught him to see’ (Kuhn, 1996 in Fellows and Liu, 2008). These assertions by Nagel and Kuhn relate to the two major paradigms employed or adopted in research; positivism and interpretivism.

#### **6.1.1.1 Positivism**

Based on the stances of ontology, epistemology and axiology, positivism, according to Fellows and Liu (2008), assumes that a phenomenon obeys natural laws and can be subjected to quantitative logic. To this end the positivists believe that reality can be observed, studied and modelled (Sutrisna, 2009). Positivists take a deductive approach to research (Gill and Johnson in Fellows and Liu, 2008). Also known as the objectivist perspective, positivism suggests that reality can be independently observed as it is single and therefore experienced the same way by everyone and stresses on objective knowledge, empirical regularities and deductive tests (Tan, 2002). Based on this, the positivist researcher is seen as an objective analyst and interpreter of a tangible social reality without affecting or being affected by the subjects of the study. The positivist paradigm aligns mainly with the quantitative approach to research which ‘seeks to gather factual data, to study the relationships between facts and how such facts and relationships accord with theories and the findings of previous research (literature)’ (Fellows and Liu, 2008). Positivism therefore is said to demand evidence, factual or mathematical.

#### **6.1.1.2 Interpretivism**

Interpretivism on the other hand, assumes that a phenomenon does not obey natural laws but is interpreted based on peoples’ conviction and/or understanding of the reality surrounding the phenomenon (Bailey, 1987; Walliman, 2001). For the interpretivist, reality cannot be observed or modelled but can only be interpreted (Sutrisna, 2009). Also known as subjectivism, interpretivism is based on an ontology in which reality is subjective: a social product constructed and interpreted by humans as social actors according to their

beliefs and value systems (Darke *et al.*, 1998 in Gamage, 2011). Fellows and Liu (2008), suggest that the interpretivist construct reality based on the person involved and as such one person's reality is likely to be different from another person's due to the difference in observations and perceptions which are also modified by socialisation (upbringing, education and training). Interpretivism, for this reason supports the concept of a multiple reality.

Although applicable to quantitative theories (Fellows and Liu, 2008), the interpretivist paradigm is largely aligned with the qualitative studies as subjectivists tend to use the interpretive, qualitative or idiographic approach to science (Tan, 2002). Fellows and Liu however warn that, the impact of social structure should be considered when interpreting how society operates. 'Societal values help to determine social structure which then impacts on values'. This suggests a recycling or interactive cycle between values and social structure. Though interpretation of the observed phenomena is greatly emphasized in the interpretivist approach, the very act of interpretation 'implies the existence of a conceptual schema or model on the part of the interpreter such that what is being observed and interpreted is assumed to conform logically to the facts and explanations inherent in the model' (Reber 1995 in Fellows and Liu, 2008). The process of interpreting a response or the behaviour of a group of people, involves induction and generalisation from some scientific schema or model (Fellows and Liu, 2008).

### **6.1.1.3 Pragmatism**

Beside the two traditional paradigms in research which relate to the two main theories of research; qualitative and quantitative theories, a review of literature on philosophical positions depict other philosophical perspectives exist for carrying out research. Saunders *et al.* (2007) mention other paradigms such as realism, pragmatism and the functionalist perspective. The comprehensiveness of reality means no one philosophical perspective is likely to fully explain all issues and based on this, Lee (1991) suggests the possibility of combining the traditional positivist and interpretivist perspectives to enable a better view of the same phenomena. From this position has emanated other combinations of the traditional perspectives and a notable one among these combinations is pragmatism. The pragmatist perspective is a philosophical stance which arises out of actions, situations and

consequences (Murphy, 1990; Patton, 1990; Creswell, 2007; Saunders *et al.*, 2007; Tashakkori and Teddlie, 2009).

Unlike the traditional perspectives, pragmatism places more importance on the problem being studied as well as the questions being asked instead of the methods and as such focuses on the outcome of the research and its applications (Patton, 1990; Saunders *et al.*, 2007). Pragmatism focuses on ‘what works’ - and solutions to research problems (Patton, 1990). For this reason, pragmatists rely on both qualitative and quantitative sources (multiple methods) of data collection, focussing on the practical implications of the research as the best means to answer research questions and problems (Creswell, 2007).

As positivism and interpretivism respectively relate to qualitative and quantitative methods, pragmatism applies to mix methods research and draw liberally from both quantitative and qualitative assumptions (Saunders *et al.*, 2007; Tashakkori and Teddlie, 2009). The pragmatist stance does not commit to any one system of reality and philosophy and as such individual researchers are at liberty to choose among the methods, techniques, and procedures of research that best meet the purposes and needs of their research. The underlying principle for the pragmatist researcher is ‘what works at the time’ and as such it is not based on either dualisms – between reality independent of the mind or within the mind. For the pragmatist, the choice between ‘what’ and ‘how’ to research is based on its intended consequences (Creswell, 2007). As the philosophical underpinning for mixed methods research, Tashakkori and Teddlie (1998) and Patton (1990) stress on the importance of focusing attention on the research problem and then using a pluralistic approach in order to drive knowledge about the problem.

### **6.3 INVESTIGATING THE CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT PRACTICES IN THE UK, AN INTERPRETIVIST APPROACH.**

Based on the review of the various factors affecting research design, this research can be said to align more with the interpretivist worldview. From the review of literature on firm decision making and behaviour; construction and demolition WM; as well as the legal

aspects of environmental and WM, this research has built a conceptual framework to understand conceptually the subject of WM. Analysis of the conceptual framework suggests that the interpretivist approach is most appropriate for the research problem and the questions being asked. As mentioned earlier, the choice of research methods in management and social sciences embodies the researcher's assumptions (i.e. philosophical perspective) about the nature of the social world, the nature of the knowledge to be obtained and the methods of gaining knowledge (Creswell and Clerk, 2007; Saunders *et al.*, 2007).

Investigating how construction companies meet the intended goals of government legislation and policy on WM requires research into the WM practices of construction firms in the UK by qualitatively analysing the decisions behind their WM actions and the resulting WM practices.

## 6.4 THE QUALITATIVE METHODOLOGY

Qualitative methodologies are explanatory in nature with the principal aim of trying to unearth answers to 'how?' and 'why?' questions (Walker, 1997), or trying to develop themes from the data (Creswell, 2003). As mentioned earlier, the choice of the qualitative approach is dependent to a large extent on the questions that need answering, the philosophical position adopted and the nature of research undertaken. A key aspect of this research is to investigate the reasons behind the WM decisions of firms and their resulting WM practices. Many researchers have various recommendations for conducting qualitative research. According to Creswell (2007), the process begins with the broad assumptions central to qualitative enquiry, a worldview consistent with it, and in many cases, a theoretical lens that shapes the study. Fellows and Liu (2008), advice that a qualitative approach to research should be adopted for its potential to get beneath the manifestations of problems and issues and facilitate appreciation and understanding of basic causes and principles, notably behaviours.

Qualitative research is said to focus on discovering and understanding the experiences, perspectives, and thoughts of participants by exploring meaning, purpose, or reality (Yin,

2013). Qualitative research involves an interpretive, naturalistic approach to the world where the researcher is located in the real world and includes practices that transform the world into a series of representations, including field notes, interviews, conversations, photographs, recordings, and memos to the self (Denzin and Lincoln, 2005). Considering the research problem and questions to be answered, conducting this research demands the researcher being located in the real world of construction companies and having close interactions with them to have first-hand information on the reasons behind WM practices and the outcomes of these practices.

Though there are various approaches to qualitative enquiry, certain common characteristics are central to all the approaches: natural setting as a source of data collection for close interaction; the researcher as a key instrument of data collection; the use of multiple data sources in words or images; inductive, recursive and interactive analysis of data; focus on participants' perspectives, meanings and subjective views; framing of human behaviour and belief within a social-political/historical context or cultural lens; emergent rather than tightly figured out; fundamentally interpretive enquiry and a holistic view of social phenomena (Creswell, 2007). Common examples of qualitative approaches are: narrative; phenomenology; grounded theory; ethnography; and case studies (Yin, 2013). The choice between these approaches depends to a large extent on a number of conditions. Yin (2013), lists three conditions as:

- a. the type of question posed;
- b. the extent of control a researcher has over actual behaviour events; and
- c. the degree of focus on contemporary as opposed to entirely historical events.

The next section discusses the reason behind the choice of qualitative approach for conducting this research.

#### **6.4.1 Types of qualitative research methods**

Different authors have grouped the approaches to qualitative enquiry into various categories. Munhall and Oiler (1986) group the qualitative approaches into phenomenology, grounded theory, ethnography, and historical research whereas Straus and Corbin (1990), group it into Grounded theory, ethnography, phenomenology, life histories

and conversational studies. After a review of the various groupings of qualitative approaches commonly used in behavioural, social and health sciences literature, Creswell regroups qualitative approaches to enquiry in five main groups: Narrative research; phenomenal research; grounded theory research; ethnographic research and case study research. The choice between the five approaches is dependent to a large extent on the choice of ontology, epistemology and axiology, rhetorical and methodological assumptions (Creswell, 2007).

#### **6.4.1.1 Narrative research**

Narrative research, as a qualitative design, involves spoken or written text giving an account of an event/action or series of actions or events chronologically connected. (Czarniawsaka, 2004). The approach is mainly applicable when individual is being studied where their stories are the unit of analysis.

#### **6.4.1.2 Phenomenological research**

This approach to qualitative enquiry is used in the study of human experiences (phenomenon) Phenomenological research involves the study of the meaning several individuals give to a concept or phenomenon based on their lived experiences. As a research approach, it describes what all participants have in common as they experience a phenomenon. During the process, the researcher collects data from persons who have experienced the phenomenon and based on this develops a description of the experience for all the individuals. Phenomenological research can be employed in the study of a phenomenon such as anger, insomnia, and grief (Moustakas, 1994). There are two basic types of this approach to enquiry: hermeneutic phenomenology (Van Manen 1990) which involves interpreting the lived experiences of the individuals in the study, and empirical or psychological phenomenology which focuses less on the interpretations of the researcher and more on the description of the experiences of the individuals (Moustaka, 1994 in Creswell, 2007).

#### **6.4.1.3 Grounded theory research**

The grounded theory approach to research is intended to generate or discover a theory, an abstract analytical schema of a process (Strauss and Corbin, 1998). Grounded theory is also based on the experiences of people but instead of merely describing or interpreting the



experiences of the participants (as in phenomenology), develops a theory that helps to explain the practice or provide a framework for further research (Creswell, 2007). The theory developed in the process is shaped by the views of the large number of participants involved in the research process (Strauss and Corbin, 1998). Grounded theory research suggest that theories in research should rather be grounded in the data from the field through the actions, interaction and processes through interrelating categories of information from the data (Creswell, 2007). Grounded theory research has two main types: systematic procedure (Strauss and Corbin, 1998) and the constructivist approach (Charmaz (2005). With the systematic procedure, the investigator seeks to systematically develop a theory that explains the process, action or interactions on a topic (Strauss and Corbin, 1998). The constructivist grounded theory approach, according to Charmaz (2006), lies within the interpretivist approach to qualitative research and involves emphasizing diverse local worlds, multiple realities and the complexities of particular worlds views and actions. It involves learning about the experiences of the participants within embedded, hidden networks, situations and relationships (Charmaz, 2006).

#### **6.4.1.4 Ethnographic research**

The ethnographic approach to qualitative enquiry generally focuses on a cultural group and examines the shared beliefs and patterns of values and behaviours (Harris, 1968). As a qualitative method of enquiry, ethnography involves usually a large group of people who interact over time and often involves an extended observations of the group mostly through participant observation where the researcher is immersed in the day to day lives of the people. Ethnography research takes many forms and the two most popular ones are the realist and critical ethnography (Van Maanen, 1988; Thomas, 1993). According to Van Maanen (1988), realist ethnography reflects an objective account of the situation learned from the participants at a site typically written in the third person point of view. Unlike the realist approach to ethnography, in critical ethnography, the author advocates for the emancipation of groups marginalised on society (Thomas, 1993). Critical ethnography entails a value-laden orientation empowering people by giving them more authority, challenging the status quo, and addressing problems of power and control (Creswell, 2007). Critical ethnography usually involves political researchers who seek to speak against inequality and domination in their research (Carspeken and Apple, 1992).

#### 6.4.1.5 Case Study research

Case study research involves the study of an issue explored through one or more cases within a bounded system (Creswell, 2007). This approach empirically investigates a contemporary phenomenon within its real life context and employs a variety of data sources (Stake, 1995; Baxter and Jack, 2008; Yin, 2013). Case studies as a qualitative research approach has widely been used by researchers and presently many typologies have been defined. Levy (2008), discuss ideographic cases studies, hypothesis generating case studies, hypothesis testing case studies and plausibility probes. According to Levy's typologies: the ideographic case studies aims to describe, explain or interpret a particular 'case' as an end in itself rather than as a vehicle for developing broader theoretical generalization and can be inductive or theory guided; hypothesis generating case studies aim to generalize beyond the data by examining one or more cases for the purpose of developing more general theoretical propositions, which can then be tested through other methods; hypothesis testing case studies are targeted at testing certain types of hypothesis; and plausibility probes, comparable to experimental designs or survey research, are intermediary step between theory testing and theory generating case studies (Levy, 2008).

Case study types can also be distinguished by the size of the boundary cases as well as the intent of the case analysis. In terms of intent, there are three main types of case studies: single instrumental case study; the collective case study and the intrinsic case study (Creswell, 2007). With multiple case studies, the inquirer purposefully selects multiple cases to show different perspectives of the issue through replication (Yin, 2003).

Proponents of the case study research design such as Yin (2013), suggest there are two main types of case studies: single and multiple case study designs which can relate to single and multiple experiments respectively. According to Yin (2013), these two main types can be further broken into four types of case studies: single case (holistic) designs; single case (embedded) designs; multiple case (holistic) designs; and multiple case embedded (designs). The choice between a single case study and a multiple case study design is dependent to a large extent on the type of research and the type of research questions that need answering as well as the resource available to the researcher.

#### ***6.4.1.5.1 Types of case study designs***

Like experiments, a case study may be designed as single or multiple (Yin, 2013). The choice between single and multiple case studies depends on the problem being studied and the time available to the researcher. Single case studies are employed with the objective of having an in-depth investigation into a phenomenon or concept to provide a rich description (Darke *et al.*, 1998; Yin, 2003). Multiple case studies on the other hand are intended to enable theoretical replication (as used in multiple experiments) where the intention is to enable cross case analysis and comparisons (Darke *et al.*, 1998). As a general rule, the evidence from multiple case studies is often considered more compelling and the overall study is therefore regarded as being more robust (Herriott and Firestone, 1983). With both single and multiple case study methods, there is the added choice of having embedded or holistic units of analysis. Based on this, Yin describes four main types of case study designs. The four types of case study design as presented by Yin (2013) are shown in the figure below.

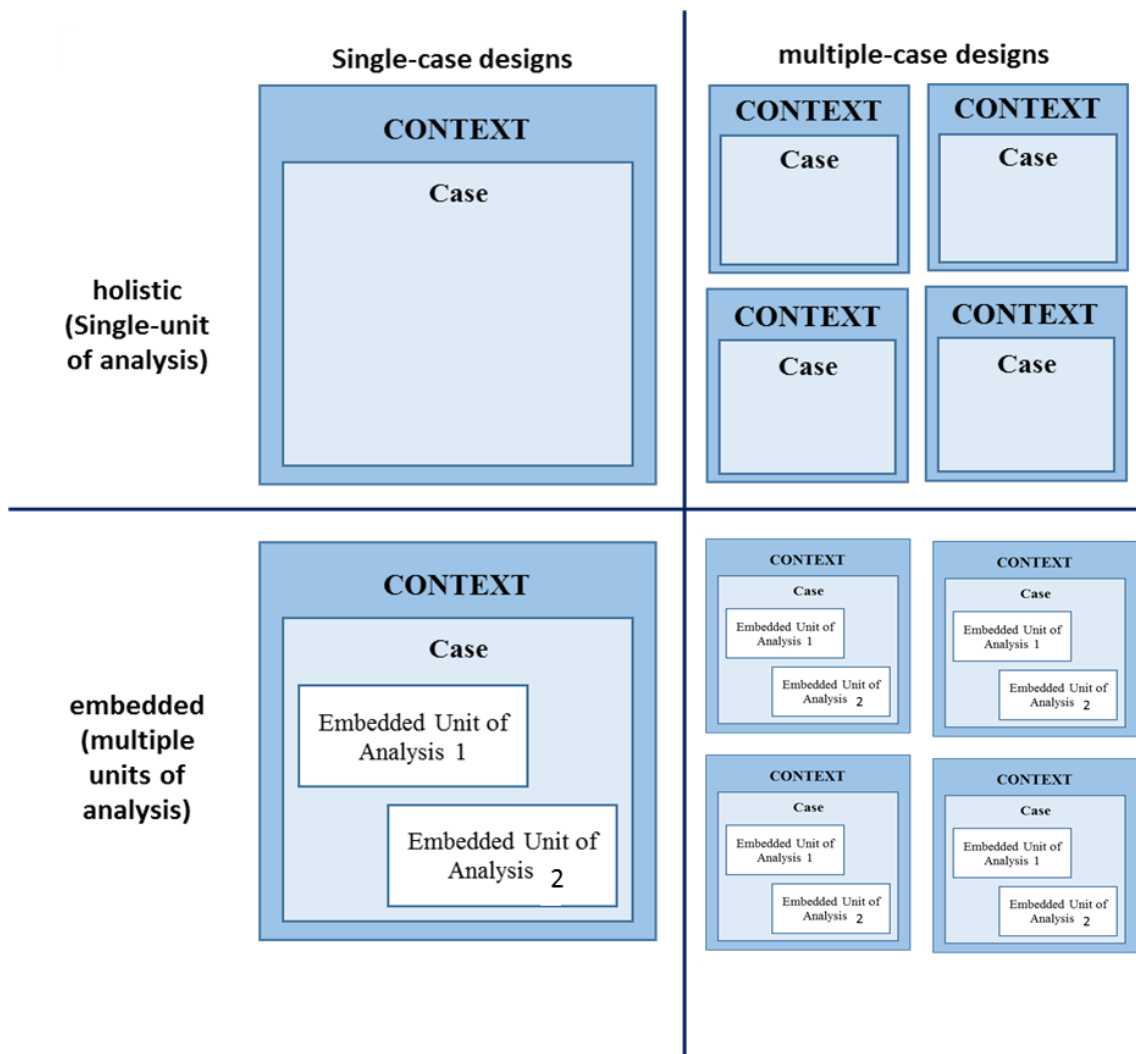


Figure 6. 1 Types of case study research designs

Source: Yin (2014)

As shown in figure 6.1 above, holistic case studies, be it single or multiple uses single units of analysis whereas embedded case studies (single or multiple) use multiple units of analysis.

#### 6.4.2 Choice of research design

Creswell (2007), suggests the following characteristics as the contrast between the various qualitative approaches: the focus of the study; the type of problem to be answered; the discipline background; unit of analysis; data collection forms; data analysis strategies; the written report. These conditions help a researcher to choose the most appropriate qualitative approach for a study.

In choosing between the qualitative approaches, Yin's guideline for the conditions and their appropriate research methods given in the table below followed (Yin, 2013).

Table 6. 1: Guidelines for the choice of Qualitative research approach

<b>Method</b>	<b>Form of research question</b>	<b>Requires control of behavioural events</b>	<b>Focuses on contemporary events</b>
<b>Experiment</b>	How, why?	Yes	yes
<b>Survey</b>	Who, what, where, how many, how much?	No	Yes
<b>Archival records</b>	Who, what, where, how many, how much?	No	Yes/no
<b>History</b>	How, why?	No	No
<b>Case study</b>	How, why?	No	yes

Based on the guidelines above, the inquiry into the reasons behind the WM decisions of construction firms and their resulting WM practices tend to align more with the question of 'what', 'how' and 'why'. The research question can be rephrased as 'why' do the construction firms manage their waste and 'how' do they achieve this. In other words, 'why do construction firms in the UK manage their waste the way they do it? Combining the guidelines by Yin (2014) with the characteristics given by Creswell (2007), a case study approach is deemed the best for answering these questions. The nature of the question demands an in-depth description and analysis of multiple cases of WM by construction firms through the use of multiple sources of data. A case study research is appropriate for this phase of this study because the focus is on contemporary events, the WM practices of construction firms, the questions relate to how and why they manage their waste and there is no control over the WM practices of firms by the researcher.

## 6.5 THE CASE STUDY RESEARCH METHOD FOR EVALUATING CD&E WM PRACTICES OF UK FIRMS

The case study as a qualitative approach to enquiry is said to be highly relevant in the construction industry; an industry that is project driven and made up of many different types of organisations and businesses (Proverbs and Gameson, 2008). Case study as a research strategy has gained recognition over the years despite criticisms from many authors (Yin 1981; 2014). As a research method, the case study has received various definitions from case study researchers (Schramm, 1971; Stake 2005). There has been a lot of misconceptions about the case study as a research method due to the limitations posed by the definitions and use given by various authors (Miles 1979; Stake, 2005; Yin, 2013). Some authors link case study to the use of a particular kind of evidence or methods (Miles 1979). Yin (1981) suggests that, the case study is neither connected with a particular kind of evidence (qualitative or quantitative) nor data collection method (ethnographies or participant observation), but an alternative research strategy. For these reasons, a case study can be exploratory, descriptive or explanatory (Yin, 1981).

In defining the case study research method, Yin (2014) adopts a twofold definition to encompass all aspects of case study research:

- a. the first definition sets case study as an empirical study that investigates a contemporary phenomenon (the case) in depth and within its real world context, especially when the boundaries between phenomenon and context may not be clearly evident; and
- b. the second defines case study as ‘an enquiry that copes with the technically distinctive situation in which there will be many more variables of interest than data points, relies on multiple sources of evidence with data needing to converge in a triangulating fashion and as a result benefits from the prior development of theoretical positions to guide data collection and analysis.

From the two definitions, Yin indicates the scope and features that make the case study research design an all-encompassing method covering the logic of design, data collection techniques, and specific approaches of data collection (Yin, 2013). The strength of the case study approach/strategy for this research lies in its ability to allow an in-depth investigation into the WM practices of construction firms.

### 6.5.1 The Propositions of the case study

Though the traditional approach to case study involves collecting evidence from the cases and using this as basis for theory building (Eisenhardt, 1989; Yin, 2003; Fellows and Liu, 2007), research by a number of authors suggest that case study research can be conducted using theories as the basis (Sutton and Saw, 1995; Yin, 2013). This serves as a guide directing attention to the issued to be examined in the scope of the research. ‘Articulating a theory about what is being studied and what is to be learned helps to strengthen a research design when doing case study research. Yin (2013), suggests that a good theoretical propositions lay the groundwork for generalizing the findings from the case study to other situations by making ‘analytic’ rather than ‘statistical generalizations’ (Yin, 2013).

Some researchers suggest that some theory development as part of the qualitative research phase is highly desired. As noted by Sutton and Staw, in developing a case study research design, theoretical propositions provide a sufficient blueprint for the study and give ‘a (hypothetical) story about why acts, events, structure, and thoughts occur’ (Sutton and Staw, 1995 in Yin, 2013 p38). To Sutton and Staw’s note, Yin (2013) adds that the propositions enable a complete research design to provide strong guidance in determining the data to be collected and the strategies for data analysis. To ensure this is well done, Cooper (1984) advices that one reviews the literature on the topic under enquiry. Though literature review is seen in many instances as a means to an end, Yin (2013) suggests that the review of literature is to help develop sharper and more insightful questions about the topic. This also helps with the development of theoretical positions about the research which in the end helps with analytic generalisations of the lessons learnt from the research.

In this research, insights from an extensive review of literature on the subject of construction and demolition WM, environmental and WM as well as WM legislation, led to the building of the conceptual framework in the previous chapter. The conceptual framework developed serves as the basis for designing a research to capture all aspects of CD&E WM activities of construction firms. This forms the basis and guides the kind of data to be collected to ensure the initial questions of the research are being answered.

## 6.6 THE RESEARCH PROCESS

The design of this research followed procedure for multiple case studies as presented in Yin (2013). According to the Yin, there are three main phases involved in the approach: defining and designing the study which includes theory development, selection of cases and the designing of the data collection protocol; the data collection phase which includes preparing and conducting the case studies (individual case studies) and writing individual case reports; and the third phase which is the analysis of individual cases as well as cross case analysis to draw cross-case conclusions, modifying the theory used for the research and developing the implications of the results and finally writing the cross-case report (Yin, 2013). The process followed in this research is shown in the figure 6.2

### 6.6.1 The research design stage

The design phase of this research can be broken into three main stages: review of literature; development of theory or conceptual framework (theory development); and case study design (including design of the data collection instruments).

#### 6.6.1.1 The literature review

This research reviewed literature from three major subject areas: environmental management and sustainability; environmental management legislation, and construction and demolition WM (these can be found in chapters 2, 3 and 4 respectively). To ensure a comprehensive view of the research area, the literature review begun by tracing the sustainability and environmental management concerns affecting the managing of waste and more especially construction and demolition WM. This enabled a clear picture to be painted for the concerns for WM and the reasons why government intervention in the area of WM is essential. From the review, it was evident that that concerns for sustainable management of materials (natural resources) have increased as a result of depleting natural resources and the need to ensure a reduction in the levels of pollution caused by human activities. It was also evident that the construction industry is a major culprit when it comes to environmental pollution as well as raw materials depletion – being the highest single user of natural resources as well as the highest single source of waste in any developed economy (Chapter 2).



To ensure the environment is well protected and natural resources are sustainably managed, government develops legislation aimed at ensuring polluting industries take responsibility by reducing their waste production levels as well as managing the amount of raw material usage sustainably. As a result of this and as a result of EU legislation and policy changes, current UK legislation and policy directives have been directed at Europeanising UK laws to meet the requirements of EU legislation which has as its base the requirement to use the waste hierarchy to ensure that materials and waste are sustainably managed. For the construction industry being the largest producer of the waste in the UK economy, it has been deemed as a priority waste streams which means more government attention has been on the construction industry and its management of material usage and waste (Chapter 3)

Due to demands on the construction industry from government legislation as well as social concerns for the impact of the industry on the environment, construction organisations engage in many practices aimed at meeting legislative requirements, social concerns and increasing profitability through reduction in the cost of managing waste. As shown in chapter 4, the practices adopted by the construction industry range from out of site to onsite practices and involves a lot of materials as well as human resources and space. The review of literature suggested that legislation is not the only driver for firms to manage their waste and this brought about the need to develop a theory or framework explaining the interrelations between the various factors affecting WM decisions and practices of firms and how they relate to the intended goals of government legislation.

#### **6.6.1.2 Development of the conceptual framework**

From the review of literature on the various aspects of the study: environmental management and sustainability; WM legislation; and construction and demolition WM practices of firms, in chapter 5, a conceptual framework was developed. In developing the conceptual framework, literature on organisational behaviour especially environmentally significant behaviour was reviewed to determine the factors driving construction firms to behave environmentally. The reviews suggest that the decision of firms to manage waste is affected to a higher extent by four different factors: cost, legislative requirements, social pressures and resource availability. The conceptual framework proposes that, these factors affect the waste and environmental policies of firms which influences the WM practices of

the firms. Based on the antecedents, actions and outcomes framework, the conceptual framework proposes that the factors influencing the WM practices will have a direct link with the WM outcomes of the firms which then serves as a basis to measure the performance of the firms against the intended outcomes of waste legislation (see chapter 5).

#### **6.6.1.3 Case study Design**

This research was conducted using the embedded multiple case study approach (Yin, 2013). This approach was chosen to evaluate the construction and demolition WM practices of firms in the UK due to the ability of the approach to explore relative effects of the different factors influencing organisational waste behaviour. The embedded approach to multiple case study was also adopted to allow room to explore the effect of project specific factors on the practices of the same firm under different conditions (through multiple embedded units of analysis).

Though the traditional approach to case study research relies on building theories from the data, Yin (2013), suggests that case study designs can be conducted using both realist and relativists paradigms. He suggests that another approach to case study research where some theory building is done to guide and direct the case study (data collection and analyses stage). This case study can be classed a theory driven case study where the conceptual framework serves as the bases to collect and analyse data (directing which information to seek in the field of the study). The building of the conceptual framework to guide the case study design was necessitated by the nature of construction and demolition WM practices: determined by factors within and outside the control of the firms; and project specific practices affected by the project features as well as factors present on each project site.

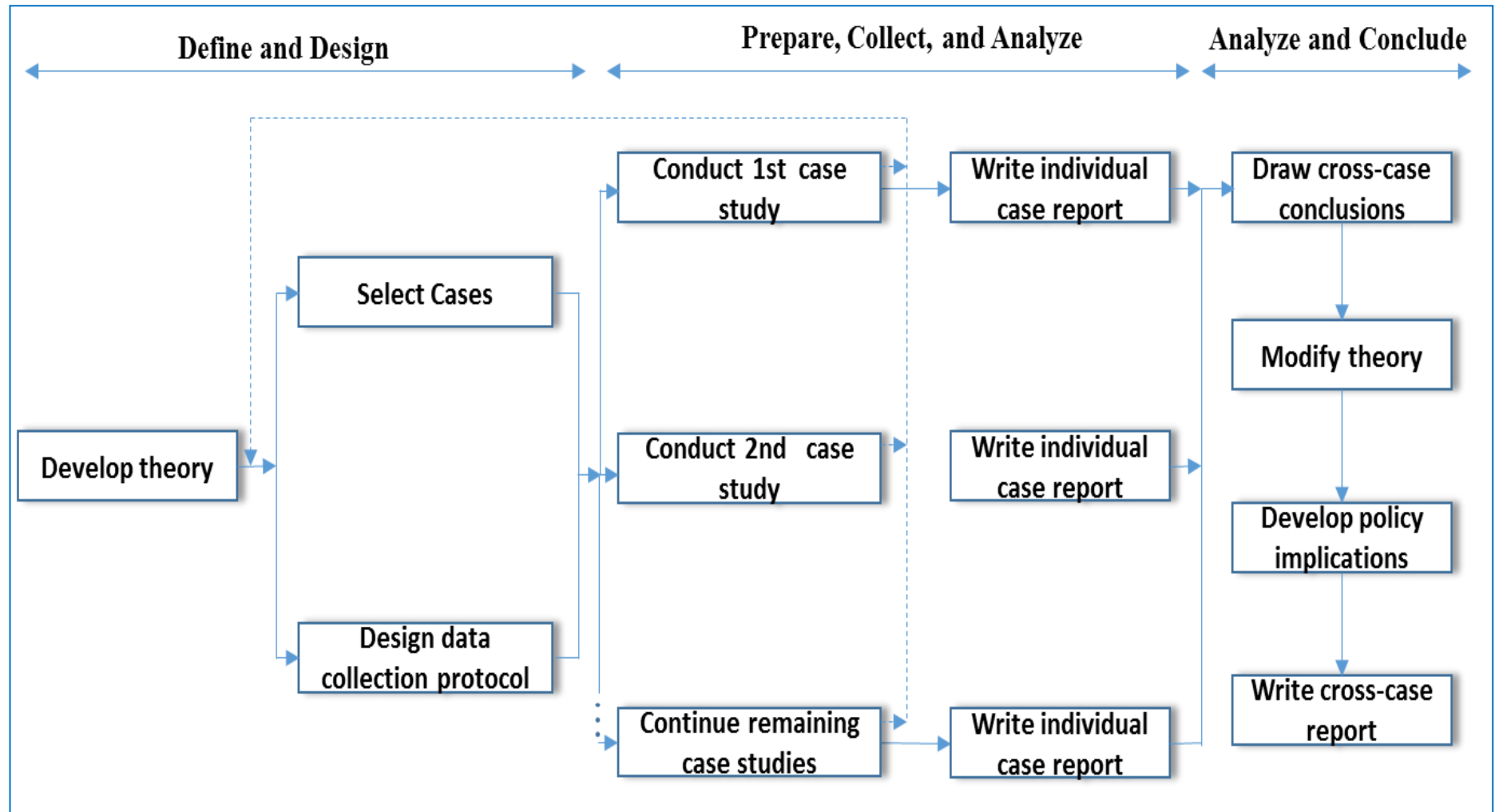


Figure 6. 2: Multiple case study research design

(Adopted from Yin, 2013).

#### **6.6.1.3.1 Units of Analysis**

One misconception in the design of case studies is the ability to clearly define what the unit of analysis of the case study is (Yin, 2013). In case study designs, the unit of analysis generally represents the case being studied and this can be either a single individual, an organisation or group, an event or even a phenomenon (Darke *et al.*, 1998; Yin, 2013). To overcome the problem of poorly defined unit of analysis, Fellows and Liu (2009) suggest that this be explicitly defined right from the onset of the research to ensure clarity in what constitutes the case study. As noted earlier, this research seeks to evaluate the WM practices of construction firms in relation to the extent to which they meet the intended outcomes of WM legislation. Due to the nature of the study and the approach used in this research, the main unit of analysis was the construction companies who were used as the case studies.

This research has four main units of analysis. The companies served as the first unit of analysis. The second unit of analysis comprised the live case study projects the companies were undertaking. The management team in charge of projects (at the project level and these included project managers and project directors) were the third units of analysis whereas was the site personnel site managers as well as operatives who were directly producing or managing waste on the projects were used as the fourth unit of analysis.

#### **6.6.1.3.2 Selection of Case studies**

As suggested by Yin (2013), in multiple case study designs, the selection of cases should be distinguished from the sampling logic used in surveys which requires an operational enumeration of the entire population and using a statistical procedure to select a specific subset (sample). With the replication logic used in multiple case studies, each individual case study is considered a whole study in its right and convergence is sought regarding the facts and conclusions for each case. The individual cases and the multiple cases form the summary case for the research. The general suggestion for the selection of cases in multiple case study design is to carefully and purposefully select cases to reflect different perspectives on the problem under study (Creswell, 2012; Yin, 2013).

A replication logic was used in this research where different companies (cases) as well as different projects (sub-cases – embedded units of analysis) from each particular company are used as a replication (Yin, 2013), to help determine the differences or similarities in practices due to project specific factors.

To ensure the research captured the best practices in the industry, construction firms that have received awards regarding environment or sustainable practices or actions are selected. In selecting the case study firms, a list of the various construction related awards schemes was made and the award winners as well as runners ups for categories relating to the environment or sustainability were selected. In all six award schemes were used comprising:

- the British Construction Industry Awards (BCI) 2013;
- the Building Awards 2013;
- Constructing Excellence Awards (CE) 2013;
- CIOB Construction Manager of the Year Awards 2013;
- Considerate Constructor National Site Awards 2013; and
- Construction News Awards 2013.

The winners and runners up from categories relating to the theme of sustainability or environmental management were selected. Initial contacts were made with the selected construction firms through letters and emails introducing the research. Through this process, 40 companies within England were contacted initially informing them of the intentions of this research and requesting them to join. Five companies responded with intentions of partaking in this research through emails and the post giving details of their environmental or sustainability managers as contact persons to in relation to the research.

#### ***6.6.1.3.3 Access negotiation***

To secure the access to projects and personnel for the purposes of data collection, negotiations were made with various people from within the companies. In some instances, meetings were arranged with the sustainability managers and directors of the companies involved in the research. Meetings held in the offices were attended by the researcher and two members of the research team at the head offices of the teams involved where negotiations were made with sustainability and environmental managers of the firms. For

some of the companies however, negotiations were done through emails and phone calls as well as video calls.

Due to the demand of the research – case studies with access to live projects, it was necessary to have detailed meetings with the sustainability and environmental managers of the firms to fully explain the requirements of the research and to ensure both teams were made aware the depth of information needed and the level of access that will be provided by the companies. For all the companies involved, a document detailing the requirements for this research was sent before the meetings to negotiate accesses were arranged. Following approved times and dates, meetings were held where requirements were discussed. The research team presented the justification for the accesses required whereas the companies also presented their levels of commitments and support they could offer.

From this stage of negotiation, each company agreed to provide a minimum of two live projects with different characteristics to be used as case studies for the research. This was purposely requested and selected to ensure replication (Yin, 2013) was achieved. Cases of different characteristics were selected to show different perspectives of the issue under consideration (Creswell, 2007) which Creswell (2005) refers to as purposeful maximal sampling.

## **6.6.2 Quality of research design**

To ensure the quality of case study evidence, Yin (2013) suggests a number of tests that must be passed. These tests include: construct validity, which seeks to ensure the correct operational measures for the concepts being studied are established; internal validity which is gained by establishing a causal relationship whereby certain conditions are shown to lead to other conditions; external validity which ensures a domain is established for generalising the findings of a study, and reliability which is the need to demonstrate that the operations of a study can be repeated to achieve same results (Amaratunga and Baldry, 2001; Yin 2013). During the process of data collection and analysis, careful steps were taken to ensure the quality of the research design was maintained. These steps are discussed below.

### **6.6.2.1 Validity of case study findings**

Although the use of case studies in research have advantages such as relevance, understanding and explanatory depth (Meredith, 1998), as reported in Aldag and Sterans

(1998), there is a common perception that case study research exhibits the tendency for construct error, poor validation and questionable generalization. The high level of subjectivity involved in the analysis of case study research or qualitative data calls for the need for verification of results or findings (Merriam, 2014; Silverman, 2015). Burbard *et al.* (2008) suggests that, different researchers may interpret the same qualitative data differently and as a result qualitative accounts cannot be held straightforwardly to represent the social world. These concerns call for the need to validate research findings or claims through a rigorous analytical approach which also has the tendency to reduce bias (Mays and Pope, 1995; Barbour, 2001; Silverman, 2015).

Simons (2009), suggests the validation of findings from a qualitative research takes two main forms: triangulation and respondent validation. Triangulation deals with seeing things from different angles to help determine the validity of claims made based on the data, whereas respondent validation deals with the process of interpretation of findings from a research. Suggestions by both Yin (2013) and Simons (2009) were taken into consideration to ensure the validity of the case study results. To ensure validity of the research, i.e. construct validity, internal validity and external validity, this research adopted a number of measures as advised by (Yin, 2013; Merriam, 2014).

#### **6.6.2.1.1 Construct validity**

A number of measures have been suggested as contributing towards construct validity in qualitative research and these include triangulation, establishing a chain of evidence, and participant validation (Yin, 2013; Burnard *et al.* 2008).

##### **6.6.2.1.1.1 Triangulation of case study findings**

Triangulation arises out of the need to confirm the validity of responses (Stake, 1995) and as Yin (2013) suggests, for multiple case studies, this can be achieved using multiple sources of data. Triangulation deals with the means to cross-check the relevance or significance of issues or the testing out of arguments and perspectives from different angles to generate and strengthen evidence in support of key claims (Simons, 2009). The use of triangulation is deemed very important in case study research due to need to produce a holistic view of the subject/object being studied by examining and analysing information from different sources and different angles (Ghauri and Grønhaug, 2002). As argued in Denzin (1989) and Flick (1992), triangulation helps to clarify meanings by identifying different ways the phenomenon under study is seen, by reducing the likelihood of

misinterpretations. Four means of achieving triangulation have been reported in the literature: data source triangulation, where different sources of data are collected on the same phenomenon; investigator triangulation, where different investigators examine the same phenomenon; theory triangulation, where investigators with different viewpoints interpret the results; and methodological triangulation, where one approach is followed by another to increase confidence in interpretation.

The essence of methodological and data source triangulation is to look at things from different angles by using different means of data collection or different data sources to get a broader view of things (Barbour, 2001). Methodological triangulation was achieved in this research by acquiring data through three different methods: interviews, documentary analysis and passive observations during site visits in all four cases. To ensure multiple viewpoints in the data set, data source triangulation was also achieved by interviewing people from different levels within the companies and on the projects. The research interviewed corporate level staff, project (management) level staff and operatives from both main contractors and sub-contractors on similar issues relating to WM.

#### 6.6.2.1.1.2 Participant/Respondent validation

Ashworth (1993) pose the question of validity in relation to qualitative research as: how can it be assured that prejudices do not determine results – that the descriptions are not arbitrary and that the findings are valid? This is where the need for participant validation comes to bear as it seeks to ensure that the views of participants are not misinterpreted. To be able to test the appropriateness of an account of the personal meaning of a situation, the best approach according to Ashworth (1993) is to ask the research participants themselves. Participant validation involves returning to respondents and asking them to carefully read interview transcripts or results of initial data analyses to validate or refute the researcher's interpretation of the data (Burnard *et al.* 2008; Yin 2013). Though respondent validation is regarded as an integral aspect of qualitative research, a number of researchers question its appropriateness due to the different concerns of both researchers and respondents. As reported in Barbour (2001), whereas researchers seek to an overview, respondents may have individual concerns and this can result in discrepancies. For this reason, Atkinson (1997) warns against the dangers of researchers romanticising respondents' accounts at the expense of their own interpretations (Barbour, 2001).



Participant validation for this research involved presenting initial results or analysis to the relevant participants and other members of the companies or projects (where possible) to ensure their views have not been misrepresented. This was mainly achieved through the production of case study reports to the participating companies and PowerPoint presentations of findings where participants were allowed to question the claims made in the findings.

#### ***6.6.2.1.2 Internal validity***

Due to the high level of subjectivity involved in qualitative research or case studies, Yin (2013) suggests internal validity is required to ensure the right inferences are made from the data received, especially interviews and documentary evidence. For internal validity to be achieved, there is the need to do pattern matching, explanation building and time service analysis (Yin, 2013). This was achieved in this research through meetings with research participants (corporate level staff) to discuss the demands of the research and ensure there was a clear understanding of the research. In some instances, this included emailing interview guides to the research participants in advance (especially for management level interviewees), to ensure they understood the questions and had the chance to seek clarification in advance where questions were not very clear. This led to the modification of interview guides where necessary. Another means used to achieve internal validity on this research was participant validation (as discussed in 6.5.2.1.1.2 above).

#### ***6.6.2.1.3 External validity***

Yin (2013) describes external validity as determining the limits to which the findings of the research could be generalised. Two main ways of achieving external validity are the use of theory for single case studies whereas replication logic could be used for multiple case studies. To ensure external validity in this research, a multiple embedded case study using four companies was adopted, ensuring the research was replicated four times for corporate level investigations and nine times for project level investigations. By this approach, all cases were compared through a cross cases analysis across the four companies whereas within each case (company), the two embedded cases (three for company B), were compared against each other. There were also a number of publications developed during the research process (see Appendix 1), which were all subjected to peer review to ensure valid arguments were made (especially for review of literature).

### 6.6.2.2 Reliability

The need for reliability in case study research is to ensure the same findings can be achieved through a repeat of the research (Yin, 2013; Merriam, 2014; Silverman, 2015). To achieve reliability, it is required to ensure the research proceeds through a transparent process, giving enough detail of the strategy as well as data analysis process (Silverman, 2011; Merriam, 2014). Also, Yin (2013) suggests the use of a case study protocol and a case study database. To ensure reliability in this research, full details of the research from the design of the case studies, through the selection of cases to the collection of data are presented (See 6.5.1.3). Also a detailed data analysis chapter is provided which shows how the research data was analysed from the review of transcripts, development of nodes (codes) to the creating of themes and sub themes (See 7.2). A case study protocol was developed for this research which included interview guides and data collection plan. The data collection plan contained a detailed breakdown of information sources: interview guides, project data sheets (See appendix 7A), observation sheets (See appendix 7D) and summary sheets; a brief description of the kind of information sought from each source, the kind of people or informants required for each data source and a justification for contacting such people. Three different interview guides were prepared: interview guide for corporate level staff (involved with WM); interview guide for project level management staff; and an interview guide for site operatives (which was developed after the first contact on site (see Appendix 9).

To ensure a consistent and systematic data collection process, the same case study protocol was employed across all four (4) cases. To ensure systematic and rigorous analyses of the data, there is the need to ensure all data collected are thoroughly analysed. Burbard *et al.* (2008) suggests that this should include the search and identification of relevant deviant or contrary cases that may not agree with the main findings. A full detail of the data analysis process is given in section 7.2 which shows how systematic and rigorous the process was. This also helps to ensure transparency in the process.

Other factors that affect the validity of claims from a case study research are: reflexivity of the researcher; adequacy of the sampling (or the selected cases); and appropriateness of the methods for understanding the topic. A justification for the adequacy of the selected cases and the appropriateness of the methods is given in section 6.5.1.3 of this thesis.

### 6.6.3 Design of Data collection Protocol

Case study research draws on multiple sources of information such as observations, interviews, documentary analysis and audio visuals (Yin, 2003; Creswell, 2007). Data collection for this research took the form of observations, interviews and documents (Miles and Huberman, 1994) which Wolcott (1992), describe as; watching, asking and examining (in Miles and Huberman, 1994). Instruments for data collection were designed to capture all three types of data mentioned above. A semi structured interview guide was used to collect interview data on views of participants on WM issues.

Three sets of interview guides were designed:

- Guide A was designed for collecting the views of environmental and sustainability managers at the strategic level of companies on the factors affecting WM decisions and practices;
- Guide B was designed for project managers and waste managers who had the overall responsibility for WM on construction sites; and
- Guide C was used to collect the views of other site staff; labourers and operatives on their views on WM practices as well as their attitude towards waste on site.

For collecting observation data, a template to record activities and actions observed on site was made. This was also used to collect data on site conditions and how they affected the activities on the project sites. Document summary sheets were also made to make the summaries of all documentary evidence data collected from the construction firms.

### 6.6.4 Data Collection

The data collection process used in this research took the form of watching, asking and examining (Wolcott, 1994). These processes involve observations, interviews and documentary analysis (Miles and Huberman, 1994; Corbin and Straus, 2008). Data collection for case studies continued over a period of seven months. To ensure the data collection and analysis process produce the best outcome, Miles and Huberman (1994), advice a concurrent approach is maintained where data collection and analysis go hand in hand. Known as initial analysis, this approach helps to identify new areas of the study where data collection needs to focus in qualitative research or case studies.

#### 6.6.4.1 Source of data

This section provides summaries of the companies used as sources of data for this research. Information on the companies and the live projects used as embedded units of analysis is provided.

##### 6.6.4.1.1 Case Study A

###### 6.6.4.1.1.1 Company Background

Established over 200 years ago, Company A is part of a British multinational facilities management and construction services company. It is currently one of the UK's top ten construction companies by (measured by turnover) turnover and also listed on the London Stock Exchange. With established businesses in the UK, Canada, the Middle East and North Africa, and annual revenues of more than £4 billion, the company employs over 40,000 people worldwide. The company is a leading support services company with a substantial portfolio of Public Private Partnership projects and extensive construction capabilities. The group has four main business segments: support services; public private partnership projects; Middle East construction services; and construction services (excluding the Middle East). The company is a proud recipient of a number of construction industry awards in the UK including: sustainability as a marketing strategy award during the construction marketing awards (CMA 2013); and a number of gold awards during the considerate constructor awards 2013. The case study covers only the construction section of the company though references may be made to other sections not related to the construction wing.

###### 6.6.4.1.1.2 Description of Case Study Projects

Two live projects were used as the source of data for collecting case study evidence for project level WM in company A. These projects are labelled Projects A1 and A2. Summaries of the projects are shown in the table below.

Table 6. 2: Description of case study projects A

	PROJECT A1	PROJECT A2
<b>Project Type</b>	Replacement project (Demolition and new builds)	Redevelopment of a power station into apartments and shops (New

		Build)
<b>Project Size (Sum)</b>	£ 22 Million	£400 Million
<b>Type of Contract</b>	JCT Design and Build	JCT
<b>Type of Client</b>	Educational (Public Sector Client)	Development company
<b>Project Duration</b>	32 months (in total)	39 months
<b>Progress at time of case study</b>	7 ½ Months	12 Months and over
<b>Site Space</b>	Large site space	Very Large space

Project A1 involved the construction of a replacement school for a city council in the west midlands region of England as part of the Building Schools for the Future (BSF) project. The project is situated on a brown field site and involved demolition of the existing school and sports hall and construction of a new school and sports hall in its place. The total duration of the project was 32 months and the project sum is £22 million. Due to the use of the existing school, the project proceeded by demolishing the existing sports hall and car park of the school to make way for the construction of the new school while the school used the existing building.

Project A2 was a huge iconic project in London which involved the redevelopment of a power station and the surrounding area of land around it into apartments in south west London. The development included the construction of 866 apartments with a mix of retail and leisure on the ground floors. The project was designed to last for 39 months with long term plans to construct a tube station as part of the development. As at the time of data collection, the project had been running for about 12 months and majority of the works was at the sub-structure level.

#### 6.6.4.1.1.3 Research Participants

The table below shows the participants of the case study and gives brief information about each participant including the projects they are associated with. A total of nine people participated in this research from company A.

Table 6. 3: Participants for case study A

Number	Company	Position	Associated Project
1	Company A	Sustainability Manager	A1 and A2
2	Company A	Waste Manager for the Project	A1
3	Company A	Package Manager	A1
4	Company A	Site labourer	A1
5	Ground works Sub-contractor	Assistant site manager	A1
6	Cladding Sub-contractor	Site supervisor	A1
7	Company A	sustainability environment and community manager	A2
8	Company A	Design Manager	A2
9	Company A	Assistant project manager	A2

#### 6.6.4.1.2 Case Study B

##### 6.6.4.1.2.1 Company Background

Company B is a construction and property services organisation that operates from regional offices covering England, Scotland and Wales, and is active in construction, services engineering, design, facilities management, property development, and plant hire.

##### 6.6.4.1.2.2 Description of Case Study Projects

For collecting data on project level WM within the company, three construction projects (live projects) were used. These projects are labelled B1, B2 and B3. Summarises of the projects are shown in the table below.

Table 6. 4 Cast study projects - B

PROJECT B1	PROJECT B2	PROJECT B3
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<b>Project Type</b>	New Build with part refurbishing	New build	New build
<b>Project Size (Sum)</b>	£12 Million (on an existing site)		
<b>Type of Contract</b>	Design and Build	Tradition JCT	Traditional JCT
<b>Type of Client</b>	Education Funding Agency (EFA)	Developer	Education funding agency (University)
<b>Project Duration</b>	18 Months	23 months	17 months
<b>Current Stage</b>	8 months into the project	17 months	10 months
<b>Site Space</b>	Large site space	Large site space	Large site space

#### 6.6.4.1.2.3 Research participants

A total of 19 people from company B participated in this research. The table below summarises the participants and their roles within the case study.

Table 6. 5: Case study participants B

Number	Company	Position	Associated Project
1	Company B	Senior Environmental Manager <sup>1</sup>	B1 B2 and B3
2	Company B	Project Manager	B1
3	Company B	Environmental Manager <sup>2</sup>	B1
4	Company B	Design Manager	B1
5	Company B	Environmental Manager on Waste	B1
6	Company B	Labourer	B1
7	Company B	Environmental Manager <sup>2</sup>	B2 and B3
8	Company B	Project Manager	B2
9	Company B	Senior Site Manager	B2
10	Company B	Health and Safety Advisor	
11	Brick Laying Company	Site Manager	B2
12	Waste Management Company	Site Manager	B2
13	Company B	Project Manager	B3
14	Company B	Senior Site Manager	B3
15	Company B	Site Manager	B3
16	Company B	Site Manager	B3
17	Company B	Project Engineer	B3
18	Company B	Project Engineer	B3
19	Company B	Roofing package Manager	B3



<sup>1</sup> senior environmental manager is in charge of WM decision at the corporate (strategic) level of the company. <sup>2</sup> Environmental managers serve as aids to project staff on environmental, health and safety, and WM issues and conduct periodic review of site activities.

Out of the total of 19 people who participates in this research from company B, the senior most person within the participants was the company's senior environmental manager. He was responsible for WM at the corporate level of the company and reports directly to the environmental director who is the overall company level person in charge of environmental management issues under which WM falls. At the project level, two environmental managers who serve as advisors to project teams were also interviewed. Each of the three projects have their project managers, site managers and other project level personnel including package managers and labourers interviewed.

#### **6.6.4.1.3 Case Study C**

##### **6.6.4.1.3.1 Company Background**

Company C is a leading property, residential and construction service group in the UK. The company operates in both private and public sectors within the UK including in areas of education, housing, transports and utilities and has capabilities in bulding, infrastructure and civil engineering, mining, mechanical and electrical design and installation, BIM and 3D modelling. The construction business of the company has internal operations in the Middle East, Far East and the Caribbean.

##### **6.6.4.1.3.2 Description of Case Study Projects**

For this case study, two construction projects (live projects) were used as shown in the table below.

Table 6. 6: Case study projects C

	PROJECT C1	PROJECT C2
<b>Project Type</b>	New Build (Technology College)	New Build (Hospital – Rapid Response Unit)
<b>Project Size (Sum)</b>	£12.5 Million (on an existing site)	£36.5 Million (on existing site)
<b>Type of Contract</b>	Design and Build	Design and Build

<b>Type of Client</b>	Education Funding Agency (EFA)	Health Trust
<b>Project Duration</b>	12 Months	18 Months
<b>Current Stage</b>	8.5 months into the project	10 months
<b>Site Space</b>	Limited site space	Limited site space

Project C1 is a school project and part of the UK government initiative to roll out the University Technical Colleges (UTC) projects which provide practical experience to attract students with interest in specific types of tertiary education related to construction and engineering. Due to the engineering nature of the project, the construction of the structures had to make allowances for bringing in industrial equipment such as 3D modelling machines, CNC machines and welding equipment to provide a factory set up as part of the school for robotics, mechatronics and electronics. Due to the demands of the project and the school calendar year within which it had to be ready, the project duration is limited to 49 weeks for a project which according to the project manager would traditionally last for between 60 to 65 weeks. Another characteristic of the project was the limited space on site due the location of the project. The research team joined the project when it was 34 weeks into the initial duration allocated. Project C2 was the construction of a rapid response unit for a hospital in the West Midlands.

#### 6.6.4.1.3.3 Research Participants

A total of eight people from company C participated in this research. A summary of the roles and backgrounds of the participants are provided in the table below.

Table 6. 7: Case study participants C

Number	Company	Position	Associated Project
1	Company C	Central Environmental Manager	C1 and C2
2	Company C	Senior Project Manager	C1

3	Company C	Project Manager	C2
4	Company C	Site Manager	C2
5	Company C	Administrative Assistant	C2
7	Electrical Sub-Contractor	Site Manager	C2
8		Project Engineer	C2

The participants for this research were largely senior management level staff on both the project and the company level. For the interview on corporate or strategic level WM, the central environmental manager for the company was the main participant. The central environmental manager 9 years' working experience with the company and For Project C1, the senior project manager was the main participant. The project manager had approximately 20 years working experience with the company and 4 years in his current position as senior project manager.

#### **6.6.4.1.4 Case Study D**

##### **6.5.2.1.4.1 Company Background**

Company D is a family owned property Solutions Company operating in the UK. The company specialises in retail distribution and health sectors with major clients being major retail outlets and high-street shops. Established in 1944, company D is a management contracting company but on some projects act as developers in partnership with their clients. As a management company, almost all sections of their projects are sublet to sub-contractors with the company maintaining oversight responsibility for all activities on their projects.

##### **6.5.2.1.4.2 Description of case study projects**

Two live projects, Project D1 and project D2, from company D serve as the source of data for this case study. Summary of the two projects are given in table 6.8 below.

Table 6. 8: Case study projects D

	PROJECT D1	PROJECT D2
<b>Project Type</b>	Retail Park - New Build on a Brown field site – with part demolition	Retail Park, Fuel station, shopping mall and cinema scattered in four places (part green field site, part brown field) with part demolition
<b>Project Size (Sum)</b>	£20 Million (£10 million construction only + extra £10 Million for fit out)	£45 Million
<b>Type of Contract</b>	JCT Design and Build	JCT Traditional contract
<b>Type of Client</b>	Investor (Contractor as the developer)	Developer
<b>Project Duration</b>	8 months	27 months
<b>Duration at time of case study</b>	6 months into the project	3 Months
<b>Site Space</b>	Large site space	Large site space

Project D1 was the construction of a retail park where the case study company, company D, acted as both the client and the managing contractor and had a contract figure of £20 million. The works by contractor D however covered only the construction phase which was £10 million. Majority of the units however had been sublet to some high street stores before construction began and duration of the project was to ensure the retail park was open for business before the Christmas season. As the contractor and developer, this project was a design and build contract with the contractor having control of the entire process. The project is situated on a brown field site which had old structures and a garden which had to be demolished for the new project. The project duration was 8 months and the research team joined 6 months into the project. At the time of visit to the project, all major structures had been constructed and work was at cladding stage with roads and carparks partially completed.

Project D2 on the other hand involved the construction of a retail park, a cinema, and a car park scattered in four project sites within the city centre. Like project D1, D2 also was situated partly on a brown field site with some aspects demolition, and partly on a green field. The cost of the project excluding the cinema was £45 million and the initial duration was 80 weeks (20 month program) but due to conditions on some of the sites making up the whole project, the project had to be extended to 109 week (27 months) also excluding the construction of the cinema. The research team joined project D2 15 weeks (4 months) into the project.

#### 6.6.4.1.4.3 Research Participants

A total of seven people from company B participated in this research. The information of the participants is given in the table below.

Table 6. 9: Case study participants D

Number	Company	Position	Associated Project
1	Company D	Environmental Manager	D1 and D2
2	Company D	Project Manager	D1
3	Company D	Site Manager	D1
4	Company D	Labourer	D1
5	Company D	Project Director	D2
6	Company D	Senior Site Manager	D2
7	Demolition sub-contractor	Site manager	D2

#### 6.6.4.2 Summary of Participants from all case studies

The table below shows a summary of the sources of data used for the case study research.

Table 6. 10: Summary of data sources

	CASE STUDY A	CASE STUDY B	CASE STUDY C	CASE STUDY D
Semi	9 interviews (1-	19 interviews	8 interviews (1-	7 interviews (1-

<b>Structured interview</b>	company sustainability manager, 2-project managers, 1-waste champion, 2-sub-contractors, 1-design manager, 1-site supervisor, 1-carpentry tradesman)	(1- Environmental manager, 2-environmental advisors, 3-project managers, 3-site managers, 2-design managers, 4-site supervisors, 2-tradesmen, 2-sub-contractors)	environmental manager, 2-project managers, 3-sub contractors, 1-site manager, 1-tradesman)	environmental manager, 1-project manager, 1-project director, 2-site managers, 1-sub contractor, 1-tradesman)

The data collection process began with interviews with selected representatives in charge of decision making at the strategic level of the case study companies. These were mainly sustainability directors, sustainability managers or environmental managers and represented the highest positions in the companies with the responsibility for decisions involving WM. Interviews at this level lasted for an average of 45 minutes and explored areas such as: company position on WM; the approach at the corporate level towards WM; the factors determining the WM decisions of the company; and the extent to which WM legislation dominate the WM factors. This stage of data collection was also used to gather documentary evidence on the WM policies, environmental policies and other documentation affecting WM activities of the companies. After this stage of data collection, initial analysis of the data was made and this served as basis to determine areas to be given more attention during the next phase of data collection.

The next stage of data collection involved visits to live projects of the company during which three main types of data was collected: interviews, observations and documentary analysis. This began with interviews of the project personnel with responsibility for WM at the site level. On some projects, these were project managers whereas other projects had a WM or a sustainability manager with the overall responsibility for WM on the project.

These interviews lasted for an average of one hour with some lasting for as long as one hour and half depending on the issues pertaining at the project site. Interviews with project leaders concentrated on areas such as: the factors on site affecting the project performance especially on areas of waste and environmental management; the characteristics of the projects and how they affect WM activities or practices; the approaches adopted on the project for WM; specific roles of other staff on the project regarding waste managing; the training activities regarding waste (where available); and the monitoring mechanisms in place to ensure compliance with demands of waste legislation. These interviews also presented the opportunity to collect any documents used on the project for the purposes of WM. These documents included site WM plans; WM procedure documents; waste data for the project (where available); and waste training documents.

After the initial interviews with project leaders, subsequent meetings were arranged with other members on site team as well as site visits to make observations during the progress of projects. This included interviews with other members on the site team including site labourers and artisans, package managers and sub-contractors. The observations and interviews at this stage were used to capture the practices used in waste prevention and management at the various stages of the projects and practices for particular work sections known to produce the most waste on site.

#### **6.6.4.3 Data Preparation**

To aid in the collection of data, interviews were recorded (audio) after which the data as well as all other audio data were transcribed into text. Summary sheets were used whenever any contact was made or document was received. These summaries were made to ensure initial ideas about the contacts were not lost over time (analysis during data collection). According to Miles and Huberman (1994), these summaries are important in ensuring the data collection process proceeds systematically and captures all relevant data. Three main summary sheets were used: contact summary sheets; document summary forms and observation summaries.

##### ***6.6.4.3.1 Contact summary sheets***

To ensure the collection and analysis of data results in the right data, after every contact with every participant of the research, a summary was produced. The contact summary sheet (See appendix 7B) was developed to summarise the outcome of interviews and clearly state the main themes in the contact. The contact summary forms were also used to

assess which information was and was not received from the contact. This was also used to check how closely the results of the interview align with the propositions in the conceptual framework (Miles and Huberman, 1994). The contact summary sheet also helped to focus the next contact as it directed attention to the areas or questions to be asked. The contact summary sheets were also used to modify the interview guide where necessary.

#### ***6.6.4.3.2 Document summary form***

Document summaries were prepared for every piece of documentary element that was received for this research. According to Miles and Huberman (1994), the document summary form (See appendix 7C) helps to the document in context, explain its significance and give a brief summary. The summary sheets prepared were used to extract the key elements such as the significance of the documents and the people it relates to the most. Documents summaries sheets in this research were made to ensure every document received was treated with due diligence and no information was lost.

#### ***6.6.4.3.3 Observation summaries***

To ensure site visits and observations also provided the needed information for analysis, the outcome of visits were also summarised after every visit. The field notes as well as pictures taken during the site visits (observations) were summarised to capture all activities or WM practices that went on during the visits.

These summary documents (See appendix 7D) were then used to modify or update the questions for subsequent visits or contacts. Not only that, the summary documents were also used as part of the data analysis process where they were coded the same way as interview transcripts or other documents.

### **6.6.5 Data Analysis**

Corbin and Straus (2008), define analysis as ‘the process of examining something to find out what it is and how it works’ (page, 46). As mentioned in Miles and Huberman (1984), the most serious and central difficulty in the use of qualitative data is that, methods of analysis are not well formulated. For this reason, Miles and Huberman advice that, there should be clarity in the approach to qualitative data analysis and this demands a commitment that requires a good deal of explicit structure. Data analysis in qualitative research ‘follows a dialectic process, not liner, where you collect some data, analyse, collect more data and refine the interpretation’ (Agar, 1980, p.9 in Wolcott, 1994).



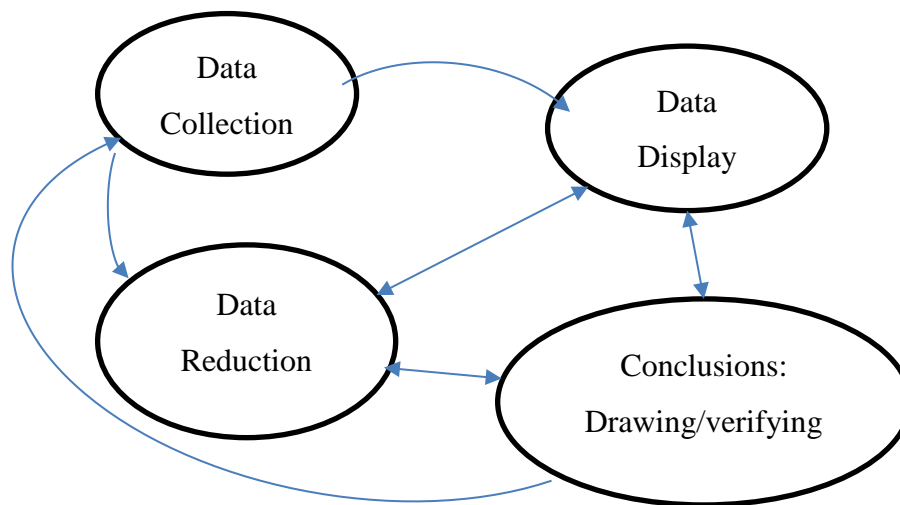


Figure 6. 3 Interactive process of data collection and analysis in qualitative research

Source: Miles and Huberman (1994)

As shown in the figure above, components of data analysis within qualitative research consists of interactive actions involving the parallel pursuit of data collection, data reduction, data display and conclusions drawing or verifying (Miles and Huberman, 1994). Data analysis during this research proceeded based on the framework above with initial analysis (display and reduction of data) leading to the collection of more data and directing which questions to ask for subsequent visits to project sites. To aid the analysis of the data, the QSR Qualitative data analysis software, NVIVO 9, was used. This helped to ensure ease of organising, coding and retrieving of data.

#### 6.6.5.1 Data analysis process

As presented in Corbin and Straus (2008), qualitative data analysis is both art and science and the process demands a balance between the art and science (Patton, 1990 in Straus and Corbin 2008). It is art because it relies on creative use of procedures to solve analytic problems and the ability to construct a coherent and explanatory story from the data, remaining flexible with the use of procedures and thinking outside the box (Corbin and Straus, 2008). Qualitative data analysis is also a science because, it systematically develops concepts in terms of their properties and dimensions and at the same time validates interpretations by comparing them against incoming data (Glaser and Straus, 1967 in Corbin and Straus, 2008). Wolcott (1994), suggests that three main processes, with varying

emphasis, are involved in qualitative data analysis: descriptive; analysis; and interpretations. Wolcott describes this general process as data transformation (Wolcott, 1994) and suggests that data analysis is one of the three aspects (process) of this transformation process. Corbin and Straus (2008), summarise the data analysis process as generating, developing and modifying concepts. Wolcott (1994), explains the three processes of qualitative data analysis (transformation) are as follows:

The qualitative process begins with descriptive analysis (description) which draws from field notes and informant's words to ensure the researcher stays closely to the data as originally recorded (Wolcott, 1994). According to Bernard (1988), description is to make 'complicated things understandable by reducing them to their component parts'. This process is to make the data 'speak for themselves' (Wolcott, 1994) and to determine what is going on within the data or on the field. The second means to deal with qualitative data is to expand and extend beyond a purely descriptive account with an analysis that proceeds in careful, systematic way to identify key factors (essential features) and the interrelationships among them. The third means of data analysis as argued by Wolcott (1994) may spring from either the first or the second process with a purpose is 'to make sense of what goes on, to reach out for understanding or explanation beyond the limits of what can be explained with the degree of certainty usually associated with analysis' (interpretation) (Wolcott, 1994). The process of interpretation sets forth the multiple meanings of an event, object experience or text (Denzin, 1998 in Corbin and Straus, 2008). Gibbs (2005 page 14) argues that, the distinguishing factor of qualitative data is their meaningfulness and this makes interpretation of such meanings a key aspect of qualitative data analysis.

#### **6.6.5.2 Analytical strategy**

The analytical strategy adopted for this research took a combination of thematic analysis, and qualitative content analysis with the help of the qualitative data analysis software NVivo. Detail of the analytical strategy used for this research is provided in Chapter 7

#### **6.6.5.3 Within case analysis**

The strategy adopted at this stage was to make sense of what is happening within individual cases and involved the process of describing the case to determine what is going on in the field; identification of the interrelationships between the they factors; and explanation of what is happening in the case and making sense of interrelationships to

make sense of what is going on (interpretation). Within case analysis began by importing the data gathered from the case study (interview transcripts, documents and observational reports and summary sheets) into Nvivo. To achieve the best out of the analysis process, the three processes of data analysis as described in Miles and Huberman were followed: data reduction; data display; and conclusions drawing or verification.

#### **6.6.5.4 Data Reduction**

Data reduction in qualitative data analysis is the first step in the analytical process and involves the abstraction of textual data through sorting, focussing, discarding and organising large segments of data into manageable forms (Miles and Huberman, 1994). Due to the huge volumes of data (text) gathered during the data collection process, ‘it becomes difficult to retrieve the words that are most meaningful, to assemble the chunks of words that go together, and to reduce the bulk into readily analysable units’ (Miles and Huberman, 1984 Page 56). Data reduction is essential due to the large amounts of data that get piled up during the qualitative data collection process leading to data overload (Straus and Corbin, 2007). A common aspect of data reduction is coding (of field notes, interview transcripts and documents).

##### **6.6.5.4.1 Coding**

To prevent the problem of data overload, Miles and Huberman (1994) recommend coding of the field notes, observations and archival material. Coding is described as an abbreviation or symbol applied to a segment of words, sentence or paragraph of transcribed field notes, in order to classify the words (Miles and Huberman, 1994 page 56). Corbin and Straus (2008) define coding as the process of ‘developing and concepts from the data’. Codes are retrieval and organizing devices that allow the analyst to spot quickly, pull out and cluster all the segments relating to the particular hypothesis, concept or theme (full details of the coding process is presented in section 7.4).

#### **6.6.5.5 Data Display**

Miles and Huberman (1984), define data display as ‘a spatial format which represents information systematically to the user’ (page 79). Displaying data in forms other than text helps present a strong case and presents a greater chance of drawing and verifying valid conclusions. Another important feature of displaying data in other formats (matrixes,

charts, checklists and figures) is that ‘narrative text alone is an extremely weak and cumbersome form of display’ (Miles and Huberman, 1984 page 79). In this research, data display takes the form of tables, figures, matrixes and pictures. Matrixes were generated with the help of the coding query option in Nvivo9. Thematic conceptual matrixes as well as photographs are presented to display findings of the research. (See section 7.5 for a discussion on data display used in presentation of findings)

#### **6.6.6.6 Conclusion drawing and verification**

As shown in figure 6.3, the final stage of the interactive process of data analysis process is conclusion drawing or verification according to Miles and Huberman (1994). The process involves identifying (noting) patterns and causal flows in the data, seeking explanations and drawing the necessary conclusions (Miles and Huberman, 1994). In this research, conclusion drawing took the form of pattern matching (Yin, 2013). The principle of pattern matching (Yin, 2013) involves constantly matching emergent empirical patterns with research questions to arrive at firmer conclusions. The frequent citing of sustainability agenda of company A is a typical example of such themes during the analysis of case study A. Conclusion drawing here matching the factors affecting WM decisions and their level of importance with the practices adopted on site to determine the extent to which particular factors drove certain practices. Another approach used in this research was clustering where concepts with similar patterns or characteristics.

#### **6.6.6.7 Cross Case Analysis**

The second part of the analytical strategy was cross case analysis where differences and similarities between the companies used as well as the projects were determined. Miles and Huberman (1994) promote cross-case analysis as a very important aspect of qualitative data analysis (multiple case analysis) because it enhances generalizability within the context of the cases as well as deepens understanding. Cross-case analysis during this study served as a means to compare the four companies used for this research in areas such as the approaches they adopted for managing waste, their strategic position on waste and the personnel involved in their WM effort. This helped to draw conclusions on the WM practices found on the projects of the four companies.

## **6.7 ETHICAL CONSIDERATIONS**

Due to the involvement of human subjects and the use of privileged data from the companies, it was important to ensure ethical considerations were made to protect both the individuals involved in the research and the company sensitive information received. Ethical considerations include informed consent, review board approval, confidentiality, handling of sensitive results, inducements and feedback (Runeson and Höst, 2009). In line with this, ethics procedures, guidelines and conduct in relation to confidentiality, anonymity, and integrity as stipulated by the University of Wolverhampton were adhered to. Ethics approval was sought from the Ethics Committee of the Faculty of Science and Engineering, University of Wolverhampton, prior to commencement of data collection.

Before data collection, all companies used for this research were made aware of the ethical considerations made and were given the liberty to take part in the research based on their informed consent. The participants (individuals interviewed) were also made fully aware of the research questions, aim and objectives and were subsequently asked to participate voluntarily by signing an interview consent form before each interview commenced (see Appendix 12 for sample of consent form). To ensure confidentiality and anonymity, company names were replaced with Company A, B C and D respectively to ensure information or responses could not be linked to interviewees and case study organisations.

## **6.8 CHAPTER SUMMARY**

Chapter six has reviewed research designs and justified the adopted research method and methodology for this research. The philosophical issues underpinning the choice of research design have been discussed and a justification made for the choice of multiple case studies as the most appropriate approach for this research. The chapter has given a detailed description of the research process: research design; selection of cases; data collection; and means of ensuring the quality of the research design. The chapter has also given background information on the four construction companies used as case studies for this research. Information on the nine life projects used as well as the participants is also provided. The chapter ends with how ethical standards were maintained throughout the research process. The next chapter (Chapter Seven) gives detailed description of how

analysis of the data was carried out to arrive at the themes and sub-themes which form the basis for presenting the results.

## CHAPTER SEVEN

### ANALYSIS OF QUALITATIVE DATA

#### 7.1 INTRODUCTION

As presented in Miles and Huberman (1988), the most serious and central difficulty in the use of qualitative data is that methods of analysis are not well formulated. This chapter first provides information on the data sources for this research and then proceeds to report on the analytical strategy adopted for this research and describes the process used to arrive at conclusions from the qualitative data (case study evidence).

#### 7.2 BACKGROUND OF DATA SOURCES

This section provides a background of the data sources used for the qualitative analysis of this research and includes background of interviewees as well as overview of the different documents collected.

##### 7.2.1 Interviewees

A total of 43 people from the four case study companies labelled company A, B, C and D participated in the interviews. The positions of the interviewees ranged from company level sustainability and environmental managers to project level project managers, site managers and labourers. Details of the interviewees are shown in the table below.

Table 7. 1 List of interviewees for the research

Case study company	Corporate Level	Project 1	Project 2	Project 3	Total Interviewed
Company A	1	5	3	x	9
Company B	1	5	7	6	19
Company C	1	2	5	x	8
Company D	1	4	2	x	7
Total					43

An interview was conducted with one person from each company who was in charge of or had an input into the waste strategy of the company to obtain information on the strategy, drivers and controls in place for WM at the corporate level. Interviewees at this level had varied backgrounds and experiences in different areas within the construction industry (See section 6.6.4.1). Interviewees from the project level can be put into two main categories. The first group of interviewees were management personnel on project sites who had the overall responsibility for WM and in some cases environmental managers who acted as auditors for environment and WM activities on the projects. These included project managers or directors, project environment and sustainability managers, site managers, and project waste managers (waste champions). The second group of interviewees were site level workers such as sub-contractor personnel, package managers, site foremen and labourers who had a direct influence on day-to-day waste generation and management.

A summary of the interviewees according to their roles is shown in the chart below.

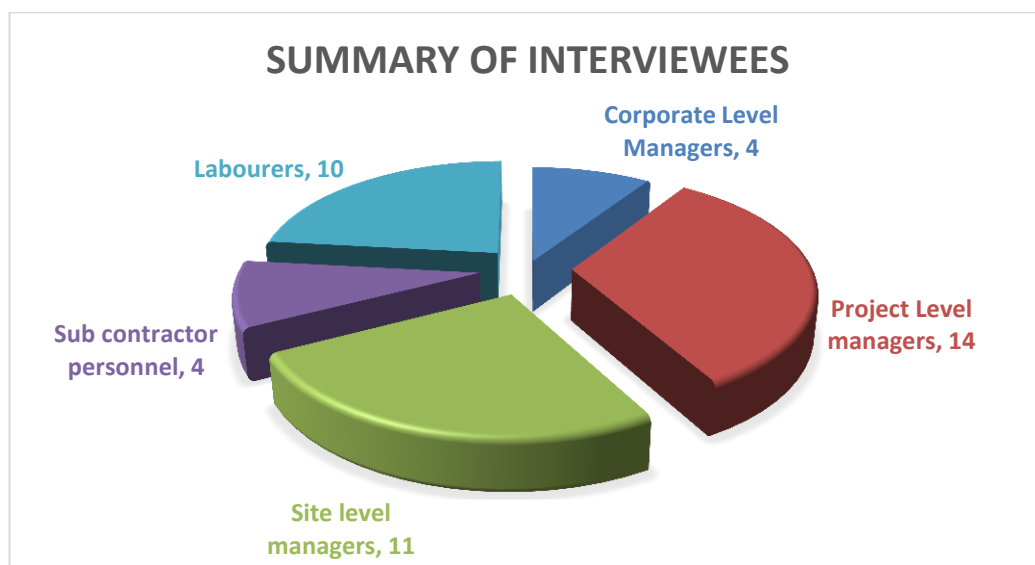


Figure 7. 1 Summary of interviewees by roles

### 7.2.2 Documents collected

A total of 26 electronic and paper documents were collected for this research. These documents relate to waste strategy of the companies and include environmental and waste policy documents, training and tool box talk documents, and WM plans used on projects. Out of the 26 documents collected, 20 were found to be more related to this research and



were included in the analysis. The categories of documents received and the companies are shown in table below.

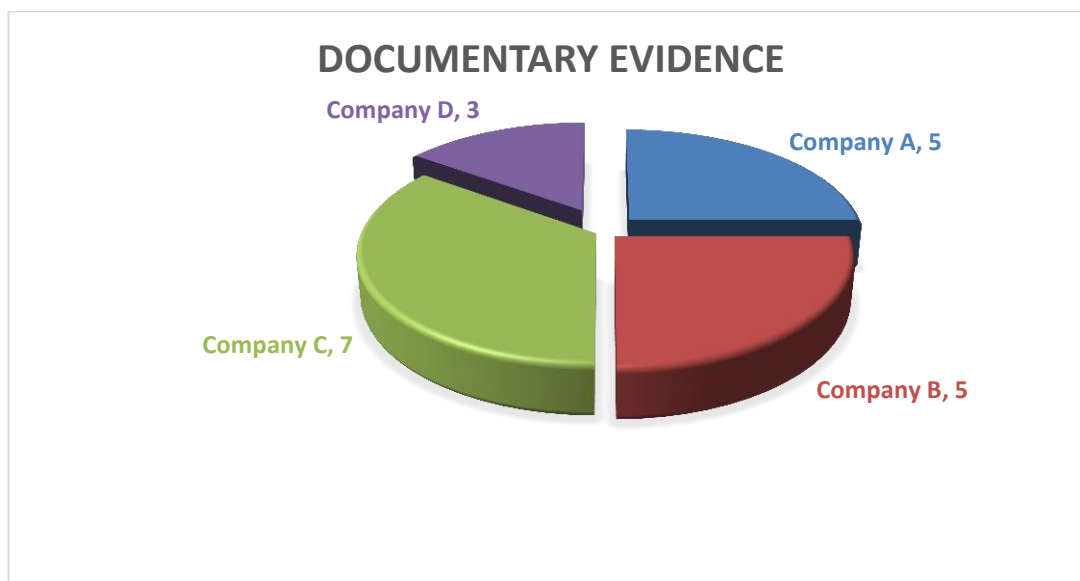


Figure 7. 2 Summary of Documents analysed

#### 7.2.2.1 Summary of key documents influencing waste management

Summaries of the documents analysed are shown in the table below

Table 7. 2 Summary of documents Company A

Document	Summary
<b>Environmental Policy</b>	Contains the company's position and strategic commitments to waste and environment issues.
<b>Waste Minimization and resource efficiency guidance notes</b>	Contains best practices for waste minimisation and efficient management of resources on projects. This resource is to help sites operate in accordance with company policy.
<b>WM guidance</b>	Provides guidance on the control of waste and ensures employees are aware of the legal, corporate and good practices concerning WM on site and in project offices.
<b>WM procedure</b>	Details the procedure to be adopted for managing waste on projects from mobilization to completion.

Table 7. 3 Summary of documents Company B

Document	Summary
<b>Environmental Policy</b>	The environmental policy forms the main basis on which WM is implemented in the company.
<b>Project Resource Management Plan</b>	The company, since the scraping of the site WM plans legislation as a legal requirement has resorted to the use of the resource management plans as the basis for planning and managing WM. This document forms the basis for setting targets for projects and putting in place measures to ensure those targets are met on all projects.
<b>Register of Regulations</b>	This document helps the company to keep track of all legal requirements and summarises all the demands of every regulation that affects the activities of the company.
<b>Sustainability report</b>	The sustainability report showcases the progress of the company on environment and sustainability issues by measuring the performance as of the previous years and setting targets and commitments for the years ahead. This document also contains case studies that demonstrate the initiatives of the company towards sustainability in the construction industry of which WM plays a major role.

Table 7. 4 Summary of documents Company C

Document	Summary
<b>Environmental Policy</b>	The environmental policy states the company's commitment to waste and environmental management issues. This document states the company's principles and strategies for WM.
<b>Smart WM plan</b>	The Company's alternative to the site WM plan and forms the basis for planning WM on projects

<b>Site WM plans for sub-contractors</b>	This document serves as a guide for sub-contractors on the company's project to identify waste types likely to occur due to their activities and consider options for managing or reducing such waste. This document is completed and submitted as part of contract documentation for the sub-contractors.
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Table 7. 5 Summary of documents Company D

<b>Document</b>	<b>Summary</b>
<b>Environmental Policy</b>	The environmental policy states the company's commitment to environmental and WM issues. It also presents the company's approach towards waste .
<b>Standard waste</b>	The standard waste document serves as the company's WM policy which specifically sets company D's commitments to WM and sets the minimum standards for managing waste on all projects
<b>Tool box talks documents</b>	The toolbox talks documents are intended to help site teams know which areas deserve the most attention and makes references to the relevant legislation for managing waste on site. This document also provides details on best practice waste reduction, and best practice WM.

### 7.3 OVERVIEW OF THE DATA ANALYSIS STRATEGY

To ensure the analysis of data followed a well organised format, all data collected for the research was prepared through transcription and editing of audio recordings, selection of appropriate pictures taken from site observations and sorting of documentary evidence. The QSR qualitative data analysis software Nvivo9 was used as the main tool to help in

data analysis by importing all data (interview transcripts, documents and pictures) into the software. Nvivo9 helped with the coding of the data (described by Miles and Huberman (1994) as an abbreviation or symbol applied to a segment of words, sentence or paragraph of transcribed field notes, in order to classify the words). Through the process of description, analysis and interpretation (stages of qualitative data analysis (Wolcott, 1994)), the files imported into Nvivo were coded based on three main coding styles (open, axial and selective coding).

## **7.4 PREPARING THE DATA FOR ANALYSIS**

To aid the data analysis process which runs concurrently with the collection of data, contact summaries were made any time an interview was made. This helped to ensure initial ideas gathered and inferred from the data were preserved. In preparing the interview data for analysis, all 43 audio recorded interviews were transcribed. To ensure originality of the interview responses and maintain integrity, interviews were only edited where grammatical errors made it difficult to carry the message in the responses. To maintain confidentiality, names of companies participating in the research and the names of respondents as well as sensitive names mentioned by the interviewees were replaced with code names to ensure anonymity. A list of the participants, their professional background and affiliation is attached in the relevant sections presenting the cases (data). To aid the analysis of documentary evidence, summary sheets were created for each document which helped to put the document in context, explain its significance and give a brief summary. The summary sheets prepared were used to extract the key elements such as the significance of the documents and the people it relates to the most. Observation summaries were also made anytime visits were made and these served as notes to help in describing observations.

After all data was prepared for analysis, the transcripts, documents and pictures were transferred into the 'internals' folder under sources in Nvivo9 which stores all data inputted into the software for analysis. To help with the analysis of data within the cases, four folders were created in the internals folder which represented the four companies used for analysis. Within each of the four folders, two sub-folders were created to separate corporate level data from project level data to ensure analysis of data was focused. To ensure familiarity with the data (interviews and documents) before the analysis (coding) process, all files were thoroughly read through. With the help of the summary sheets, a

better understanding of the data was achieved before describing, analysing and interpretation (Wolcott, 1994).

## 7.5 CODING

Coding, the process of ‘developing concepts from the data’ (See Corbin and Straus, 2008), commenced as soon as the first set of data was collected. As described by Richardson and Morse (2007 in Saldana, 2012), the coding process is not just labelling chunks of texts, rather it is a linking process that leads you from the data to the idea (code) and from the idea to all the data pertaining to that idea. Throughout the coding process, a number of terms are used and these are explained below. Common terms to be used in this section under coding are codes, nodes, categories, themes and sub-themes. A ‘code’, referred to as a ‘node’ in Nvivo, is the smallest unit of analysis applied to words, chunks of words or paragraphs (Miles and Huberman, 1994). Categories on the other hand refer to a cluster of codes according to a pattern (similarities or regularities) which help to actively facilitate the analysis of their connections. Themes refer to a cluster of categories used to form a pattern (based on similarities or difference) and form the main basis for presenting the findings from the analysis where sub-themes on the other are divisions of a main theme into different dimensions.

The coding process followed a cycle of what Saldana (2012) describes as encoding and decoding where decoding was the process of making sense of an extract or passage from the data. After this, encoding of the sense made of the extract or passage is done by coding (giving a name code) to that extract or passage based on the sense made of it. This resulted in a mixture of data summation and data complication (Coffey and Atkinson, 1996 in Saldana, 2012). Through this process, the data was broken apart in analytically relevant ways in order to lead toward further questions about the data.

A total of 297 nodes/codes were generated from the data collected and these were grouped into free nodes and tree nodes. ‘Free nodes’ as used in this research refers to codes generated through micro analysis of (digging beneath) the data (open coding) to discover all meanings inherent in the data. The codes were further developed into categories (tree nodes) which were grouped further to develop themes and sub-themes for the analysis. Categories refer to a collection of nodes which are attributes of a particular concept (tree nodes). Sub-categories of attributes, known as dimensions were developed to break down attributes into sub groups.

Different coding approaches were used in the coding of the data for this research. As mentioned earlier, the coding process began with predefined codes. These initial codes formed the main nodes for the coding process. The predefined codes emerged from the conceptual framework and consisted of: two codes which formed the two main themes, corporate level WM and project level WM; two sub themes, one for each of the main themes, drivers for corporate level WM, and WM practices (respectively); and four categories which all fall under the drivers for corporate level WM theme. Aside the predefined codes, two main approaches to coding were used to code all data sources used for this research. These are open coding, and axial coding.

A summary of the predefined codes is shown in the table below

Table 7. 6 Predefined codes for data analysis

Main Theme	Sub-theme	Categories
Corporate level WM	Drivers for WM	Economic considerations Social imperatives Legislative requirements Resource availability
Project Level WM	WM practices	

### 7.5.1 Open Coding

Open coding was the first part of the coding process and consisted of reading the edited transcripts and documentary evidence line-by-line and coding the concepts found in the data through line-by-line, paragraph-by-paragraph and incident by incident coding procedures. Using the objectives of the research, the conceptual framework developed for data collection, and the predefined codes as the basis, codes were freely generated. To ensure the coding process gave the best outcome, portions of the interview transcripts and documentary evidence which did not relate to the aims of the study were not coded. The choice of codes for responses to any particular question was dependent on the aim of the question and the response given by the interviewees.

An example of the open coding process is explained below using responses to the question ‘why does your company manage waste.’ This question was to help identify the drivers for WM by the construction companies and as such responses would form sub-theme drivers for WM. In answering this question, the Environmental Manager for Company C answered as follows: *Reputation to the company - absolutely. You want to be seen as a company that keeps things clean and does it properly and the client sees what you do on site.* This statement was coded under the label ‘company image’. In responding to this same question, the environmental advisor for Company B had this to say: *‘did I mention the halving waste landfill commitment, so there’s industry led initiatives that, as a major contractor, we sign up to demonstrate that we’re acting responsibly as a company.’* This was also coded under the label ‘company image’. Other interviewees gave answers suggesting that company image was a major driver for WM within their companies. Other labels (codes) such as: ‘client demands’; ‘benchmarking’; ‘environmental concerns’; ‘company vision’; and ‘requirements of standards’ were given to other answers that also related to the reasons why the companies managed waste (drivers of WM).

In all 21 codes were generated from the question ‘why does your company manage waste’ which fall under the drivers for WM sub-theme. The codes are shown in table 7.7.

Table 7. 7 Codes on question regarding reasons for managing waste (Source: Field data)

Nodes	
1	Benchmarking
2	Environmental concerns
3	Cost of waste management
4	Company image
5	Resource wastage
6	Environmental standards
7	Ratings and support services
8	Compliance with legislation
9	Resource demands for compliance
10	Cost of compliance
11	Effects of non-compliance on company activities
12	Clients

13	Company reputation
14	Client demands
15	Client expectations
17	Corporate social responsibility
18	Competitive advantage
19	Prosecution for non-compliance
20	Audits by external bodies
21	Cost of waste

Response to all the other interview questions as well as documentary evidence were subjected to similar processes to ensure all the data was duly coded. A total of two hundred and sixty seven (297) open codes were generated throughout the process.

Due to the iterative nature of the open coding process, there were instances where codes given to particular chunks of data were re-labelled or merged with other labels (codes) to ensure consistency or give a more representative label (code) as a better picture emerged. For example, under the reasons why companies managed waste section (shown in table 7.3 above), codes such as ‘client’, ‘client demands’ and ‘client expectations’ were identified to be closely related and were merged to get the ‘client demands’ code. Similarly, codes like ‘company image’ and ‘company reputation’ were identified to mean the same thing and were combined into ‘company image’.

### 7.5.2 Axial coding (development of categories and themes)

After the open coding process used in splitting up the data to make sense of the data, it is necessary to reassemble the codes (nodes) into categories to make meaningful categories and themes. The process of developing categories is to search for patterns in the codes and categorise them based on their commonalities. As explained in Saldana (2012), axial coding describes a category’s properties and dimensions and explores how the categories and sub-categories relate to each other. Taking the codes developed from the open coding as standalone elements did not provide much information and as such there was the need to categorise them based on similarities and differences to help make better meaning of them. This process led to the grouping of nodes to form categories which were further grouped to



form sub-themes. An example of a sub-theme development (waste management strategies at the corporate level) is discussed in this section.

The development of the ‘strategies towards waste management at the corporate level’ category began by putting together nodes from the coding of corporate level data that related to strategies for managing waste. These nodes were selected by running a coding query in documents that related only to the corporate level data. Interview transcripts and documents from the corporate level of all four companies were extracted through this process with the option of finding relationships between all nodes that relating to strategies. The nodes were grouped into six main categories which were strategies for: sub-contractor selection; material selection; resource efficiency measures; design to reduce waste; the use of low waste construction technologies; and methods to manage and handle materials on site. These six sub-categories were grouped into the three main stages of projects: design; procurement; and construction (see figure 7.3). The groupings were made purposely to identify which of the strategies related to the three main stages of projects.

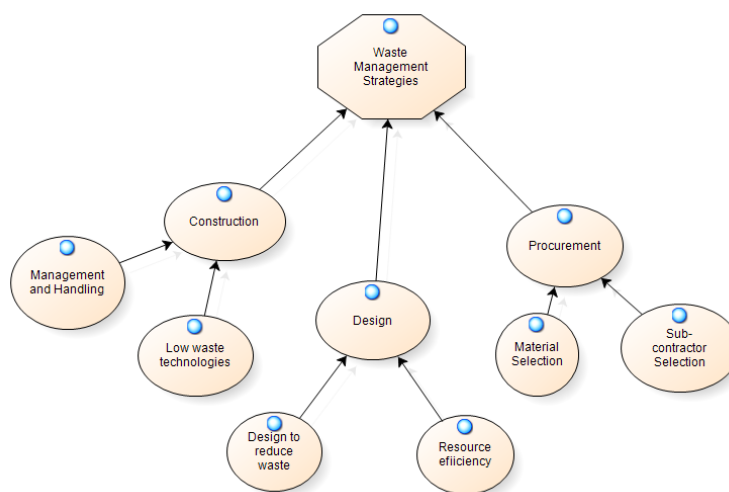


Figure 7. 3: link between waste management strategies at corporate level and child nodes

(Source: Field data)

### 7.5.3 Sub-themes for corporate level waste management

Approaches to waste management, which is a sub-theme under the corporate level waste management theme is used here as an example to demonstrate how the sub-themes were developed.

After the creation of the waste management strategies categories, other nodes relating to waste management at the corporate level were further grouped through the axial coding process described in 7.5.2. It was identified that all the strategies for waste management formed part of the six approaches to manage waste at the corporate level which included: waste management responsibilities; the use of waste management companies; planning for waste management; training and education of staff; the use of the waste hierarchy; and strategies towards waste management. These six different approaches were grouped together through further integration of the categories and sub-categories to form the approaches to waste management sub-theme (Figure 7.4) of the corporate level WM theme.

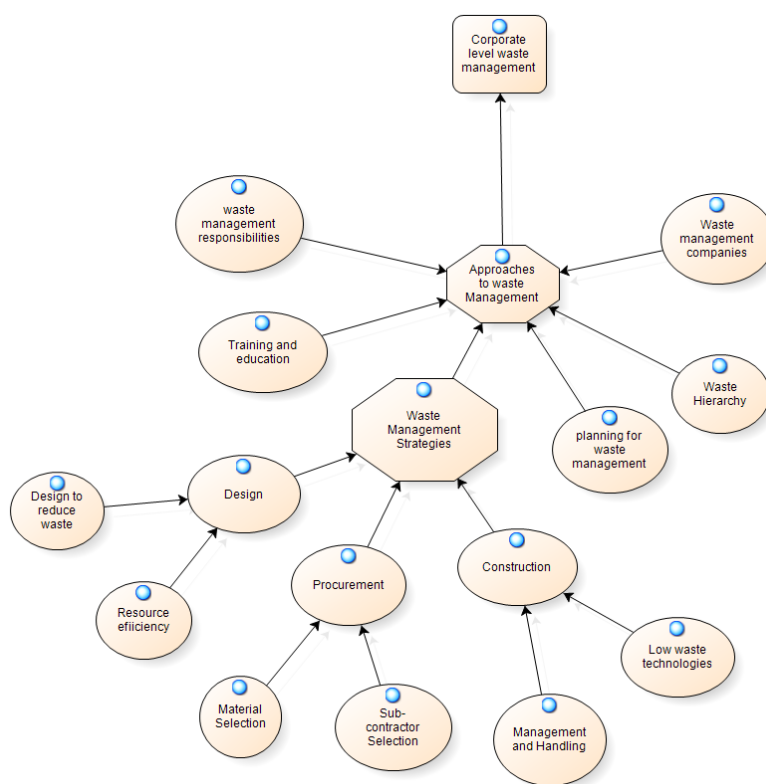


Figure 7. 4: The sub-theme ‘Approaches to waste management at the corporate level’

(Source: field data)

Further integrating the codes developed for corporate level WM and going through the categories and sub-themes developed, it was necessary to group all the insight from the corporate level data into a common theme. This led into the categorising of the insight based on commonalities in the categories to determine the sub-themes into corporate level WM. As shown in figure 7.5, sub-themes developed for corporate level WM were: vision

for WM; WM documentation; and drivers for WM. Similar processes were used to create the remaining themes and sub-themes

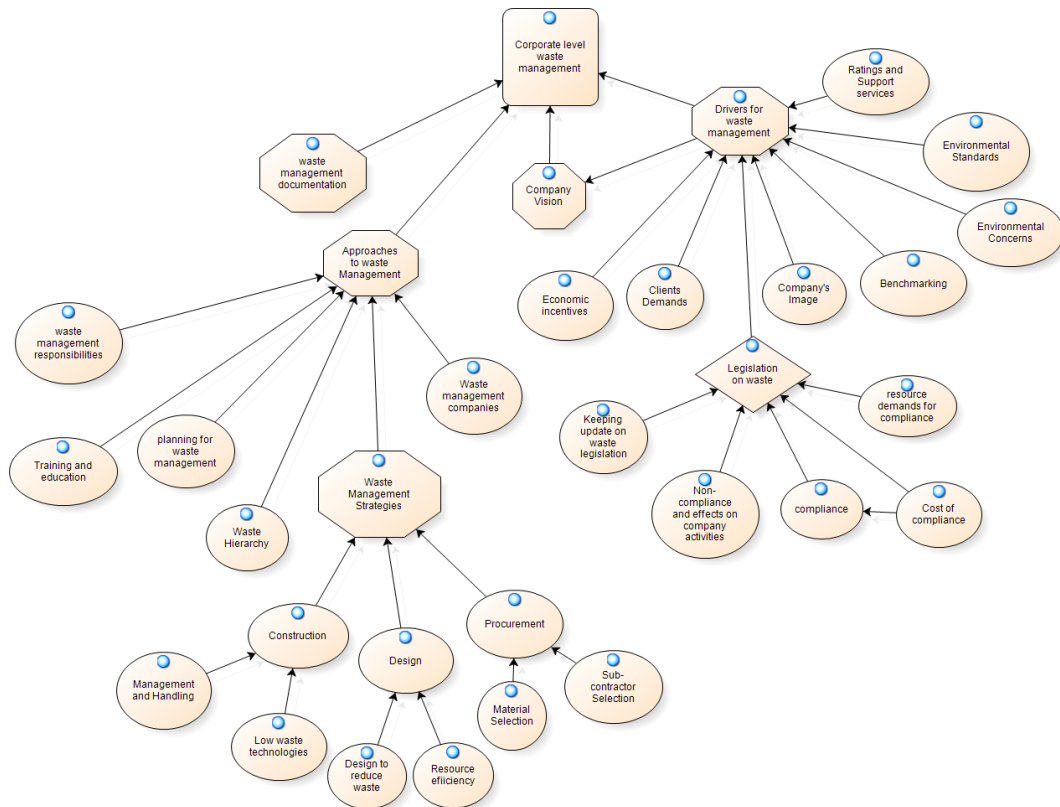


Figure 7. 5: The ‘Corporate level waste management’ theme and its sub-themes

(Source: Field data)

## 7.6 DATA DISPLAY

To help give a better representation of the outcomes of the data analysis (provide detail for structures, processes and activities), models, diagrams and pictures were used. The generation of models and diagrams was done using either the Models feature in Nvivo 9 or Microsoft PowerPoint (MS PowerPoint) 2013. The models developed in NVivo were created to give a visual display of the categories, and sub-categories identified in the data and formed an integral part in the presentation of the results of the study.

The diagrams developed in MS PowerPoint were used to aid easy presentation of the outcomes of the research, especially where diagrams explained activities or processes undertaken at a particular stage on projects. Diagrams developed in MS PowerPoint were

used in the results chapter to illustrate emerging patterns from the research. These diagrams were mainly generated through memo writing and the review of the outcomes of the data analysis process. An example of the diagram development process using MS PowerPoint is explained below using the diagram for the sub-theme, ‘WM Governance’

From the analysis of the data on the roles played by different people at the corporate and project levels to manage waste, it became evident that there was a management structure in place for ensuring waste was sustainably managed. All codes relating to the roles played by people at the corporate level relating to WM (from interviews and review of documents) were captured under the category ‘WM responsibilities’. The grouping of all data for the research into sub-folders under sources based on the different companies made it possible to be able to extract information for a particular company using coding queries. A complex coding query was run for all codes relating to WM responsibilities using data from company A’s corporate level only to help extract only the relevant data for the company. After extracting the relevant references from the data, a coding memo was written for WM responsibilities in company A which explored the various roles played by different people in company A’s corporate level for the purposes of WM.

From the process described above, it emerged that the highest role with responsibility for WM in company A was the chief sustainability officer who headed the sustainability teams in the company and had oversight responsibility for all corporate level WM. The sustainability teams were in charge of setting sustainability targets for the company and also for setting the targets for WM on projects as well as designing the procedure for managing waste on projects. Beyond this phase, it was identified that project teams handled WM with the project manager selecting a waste champion on site to lead and oversee all WM activities for the project (See section 8.5.1.4).

Based on the process identified through the memo writing, it was appropriate to find a simple and effective way of displaying the result and a diagram shown in figure 7.6 below was created.

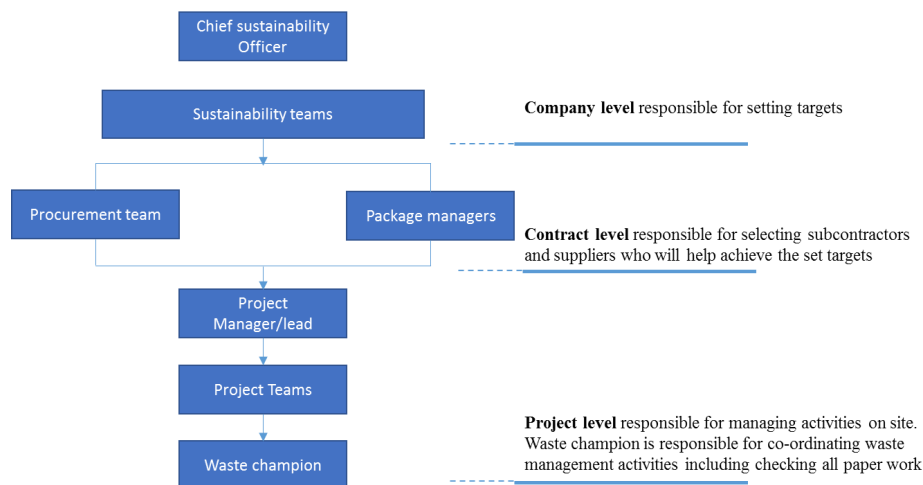


Figure 7. 6 WM governance in Company A

(Source: Field data)

## 7.6 CHAPTER SUMMARY

This chapter has described how the case study data gathered through this research was analysed. Qualitative data analysis techniques were used in this research and began by coding all the data collected (interview transcripts, document, and pictures) into Nvivo9 using 8 predefined codes developed from the conceptual framework. The data was then broken into smaller chunks and coded through the process of open coding. The codes (nodes) were further explored and grouped into categories (through axial coding). Further exploration and categorisation led to the development of sub-themes and themes which form the basis for reporting the results from the research. This chapter presents examples of how the data analysis proceeded using the ‘drivers for waste management’ and ‘strategies to manage waste on projects’ used sub-themes as examples. Diagramming as a means of data display was also used to demonstrate alternative means of presenting the results of the research better.

The next chapter presents results for ‘waste management at the corporate level’ which is an output from the process described in this chapter.

## **CHAPTER EIGHT**

### **WASTE MANAGEMENT AT THE CORPORATE LEVEL**

#### **8.1 INTRODUCTION**

Following the analysis of the data collected for this research as shown in chapter 7, this chapter presents the results of the analysis of corporate level WM for the four companies used for this research. It reports on: corporate waste management vision; divers; approaches and strategies, mapping out best practice as well as critiquing differences in approaches adopted by different companies towards achieving the same ends.

#### **8.2 FRAMEWORK FOR CORPORATE LEVEL WM**

WM at the corporate level is discussed based on Figure 8.1.

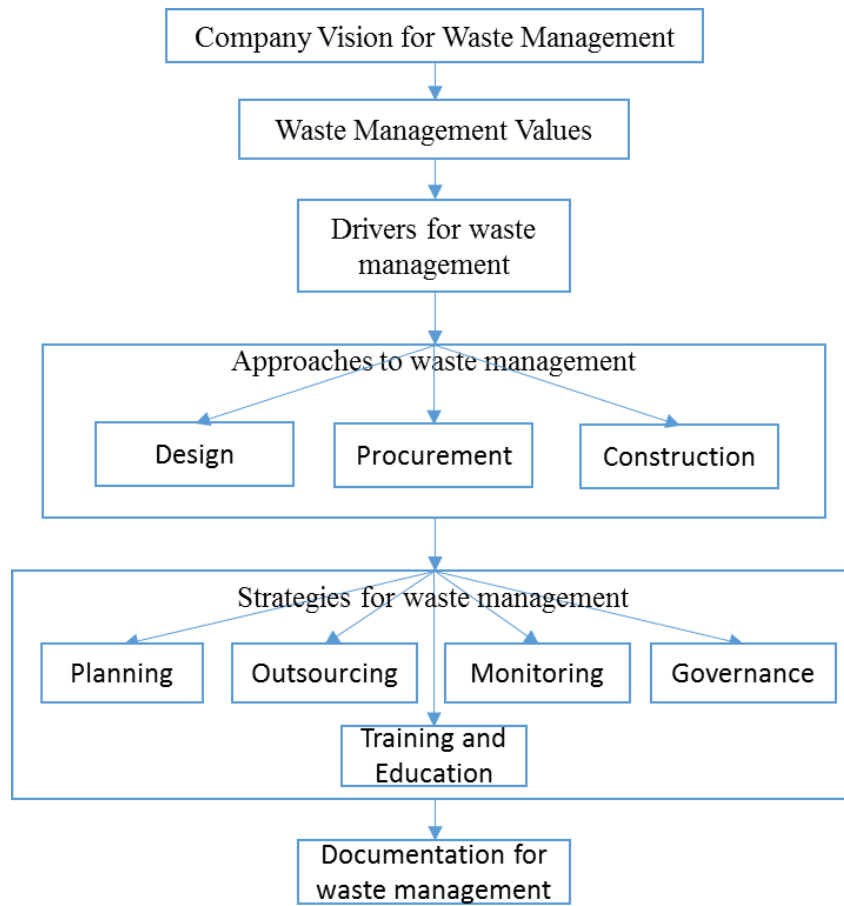


Figure 8. 1: Framework for corporate level waste management

As shown in figure 8.1, WM at the corporate level of all four companies is presented in four major themes. Vision and values for WM; drivers of WM; approaches towards waste; and strategies to manage waste. Company vision with regards to WM explains what the company seeks to achieve with their WM efforts and this is fuelled by a number of values which determines the stance of the company on WM. The factors that drive WM are then discussed followed by the approaches of the company towards meeting their WM vision. Approaches emphasise on three main levels which represent the major phases in the construction process; design, procurement and construction phases. The chapter ends with a discussion of the operational strategies used to implement the corporate vision for WM.

### 8.3 WASTE MANAGEMENT VISION AND VALUES

The vision and values for WM differed for all four companies used for this research though the ultimate aim of all companies was to ensure waste is sustainably managed. The visions and values for all four companies are presented below.

### 8.3.1 Waste Management Vision and Values - Company A

Company A has a vision to be an industry leader in terms of sustainability and this vision drives their WM agenda. The company recognises waste as part of its environmental impact and has a sustainability policy to effectively manage and improve its environmental performance by minimising the influence of its business on the environment. With this vision, the company seeks to *drive continual environmental improvement by effectively managing and implementing environmental management systems in compliance with environmental management standards* (Environmental Policy, Company A). Values fuelling the company's waste management vision are the beliefs that construction industry is a major user of raw material, and the producer of large volumes of waste which affect the environment. The company believes pollution prevention and reduction can be achieved through resource management practices. The company subscribes to the 2020 sustainability strategy and seeks to ensure zero waste is sent to landfill by 2015. Company A has a set target of 96% diversion from landfill for its construction processes and regards its suppliers as key to ensuring WM targets are met.

### 8.3.2 Waste Management Vision and Values - Company B

Company B regards itself as a major player in the construction industry and a sustainability champion. Company B considers waste generation as resource wastage and has a vision to *'develop a business that has zero impact on the environment through a cradle to cradle approach that guides how we (Company B) design, construct, and manage our buildings'*. The vision concentrates on resource efficiency to prevent waste generation, and divert waste from landfill and to be a *responsible* company. This vision is based on the belief that inefficient use of resources is the main source of waste generation. As signatory to the Halving Waste to Landfill by 2012 Commitment offered by WRAP, the company believes it is possible to prevent waste from ending up at the landfill through efficient management of resources. For this reason, Company B seeks to *'make efficient use of natural resources and promote the use of sustainable materials, especially timber, through the adoption of its responsible sourcing policy'* (Environmental Policy, Company B). The company targets to *"raise awareness of environmental issues through training and development of all employees, and to encourage initiatives that enhance environmental performance"* (Environmental Policy, Company B). At the time of data collection, the company had a target of 95% diversion of non-hazardous waste from landfill (Sustainability Policy, 2012).



### 8.3.3 Waste Management Vision and Values - Company C

The vision of Company C is to *"be a world-class, customer-focused company that invests in, builds, maintains and renews the places where we live, work and play"* (Environmental Policy). In terms of WM, the company vision is to seek to improve environmental performance by a best practice approach to minimise waste while complying with government legislation. The company also considers waste generation as a financial concern and this contributes to the vision to ensure waste is minimised. The vision was summarised by the Central Environmental Manager as follows: *that's all we can ask, you minimise what you produce where you can and you stay within the law and best practice - those are the good bits that we add on where we can* (Central Environmental Manager). To achieve this vision, the company recognises senior management, designers, clients, subcontractors and suppliers as having key roles to play in this process and as a result requires them to take responsibility to ensure their actions contribute towards waste minimisation. There is the belief that involving all members from top management to suppliers and sub-contractors will contribute towards waste minimisation which is a key aspect of their environmental protection agenda.

Company C requires senior management to: *review the policy and set objectives for environmental performance and targets; seek to influence their clients to adopt, and their designers to provide solutions that benefit the environment; and to work with their supply chain to improve their own environmental performance* (Environmental Policy). Waste reduction is also part of the company's commitment to the WRAP Halving Waste to Landfill Commitment initiative.

### 8.3.4 Waste Management Vision and Values - Company D

Company D has a vision of ensuring *the amount of its waste sent to landfill is reduced to 0% by the end of 2014* (at the time of data collection) through a best practice approach. This vision as reported in the group environmental policy, is to ensure *that environmental impacts from our activities are minimised in our work* and focuses on making individuals on project *'understand how they are expected to operate'*. This includes *operating in a safe and healthy way and contributing positively to the communities they work in* (Group Environmental Policy, Company D). The company concentrates on waste reduction and reuse which according to the environmental manager is the main means by which waste to landfill can be reduced. The vision is fuelled by the Company's belief in the role their sub-

contractors and suppliers play in the WM process. As reported in the environmental policy of the company, *‘whenever practical, the company seeks to meet or exceed industry good practice on environmental and sustainability issues’*. Specific objectives to achieve this vision listed in the company’s environmental policy include: full compliance with environmental legislation and requirements relating to their work; operating in accordance with company environmental procedures; achieving environmental targets and pollution prevention and ensuring continuous improvement. In line with the company’s vision, Company D has a commitment to report their waste to WRAP (Waste and Resources Action Program) in support of national commitments to reduce waste to landfill.

From the results, it can be concluded that though all companies have different visions fuelled by different values, the overarching objective in all companies is to ensure sustainable management of waste. The vision and values for waste management will be the main driving force directing the efforts of the company. As shown above, all companies have commitments to reduce waste sent to landfill, which is the intended goal of government WM legislation. It can also be identified that other industry wide initiatives like the Halving Waste to Landfill Commitment by WRAP has a major role to play in determining the vision of some companies. The next section discusses the factors driving corporate level waste management vision.

## **8.4 CORPORATE LEVEL WASTE MANAGEMENT DRIVERS**

The visions for waste management discussed in Section 8.2 are driven to a large extent by a number of factors which determine why the companies manage waste as well as the approach they take to manage their waste. These drivers are discussed under internal and external drivers, where internal drivers are those factors inherent in the companies whereas external drivers are introduced by forces outside the companies. The extent of influence of the drivers on WM are determined (ranked) based on the level of emphasis respondents made to particular drivers and also based on the emphasis given to the drivers in the policy documents of the companies.

### **8.4.1 Drivers for Waste Management - Company A**

A summary of the drivers for WM in at the corporate level of company A is shown in Figure 8.2. As seen from the figure, the key drivers for WM are: company sustainability vision; economic considerations; company image; and client demands.

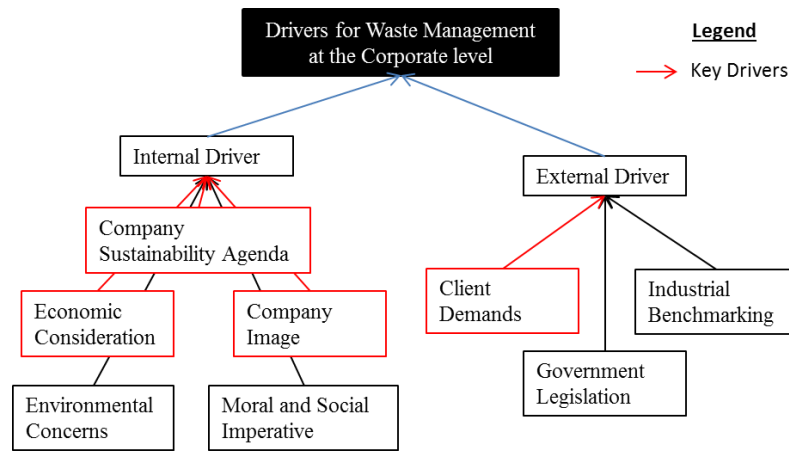


Figure 8. 2: Drivers for Waste Management - Company A

#### 8.4.1.1 Internal drivers of WM Company A

As shown in Figure 8.2, the internal drivers dictating WM in company A are: sustainability agenda; economic considerations; company image; environmental concerns; and moral and social imperatives

##### 8.4.1.1.1 Sustainability agenda of the company

Company A's sustainability agenda, which incorporates resource use, waste prevention and environmental protection is the number one driver for WM at the corporate level. The quest to achieve these sustainability goals drives the overall WM agenda of the company as described by the sustainability manager of the company:

*“At Company A (name withheld), sustainability, it really is everything. Whatever our impact is, whether it's construction, or a refurb, or maintenance, or anything that Company A operate a business, we impact to community, or we deliver a programme of work and we engage with that community, we use materials and manage waste, everything we do is in our sustainability agenda.*

Sustainability manager, (construction business) Company A.

From his interview, it was deduced that though the aim of the company is to *make profit after paying all of its workers*, achieving sustainability is a major objective the company. The need to be sustainable is acknowledged by the company's Environmental Policy, the Waste Guidance Document and Waste Procedure Document as one of its contributions to society, and as a source of positive financial outcome.

Sustainability is the biggest driver of WM in the company because of the economic potential, the environmental benefits as well as the influence on clients.

#### ***8.4.1.1.2 Economic considerations***

The next driver for WM is the cost associated with waste generation. As a company with the main aim to maximize profit, the costs associated with waste generation and disposal and the negative influence of this cost on the profitability of the company drives WM. Cost elements affecting waste generation include: cost of materials in the waste, the cost of man hours put into the process, the cost of permits, the cost of transportation, and charges for landfilling or disposal of waste.

#### ***8.4.1.1.3 Company Image***

The current focus of the industry on sustainability and environmental concerns drives Company A to manage waste to ensure its image as a sustainable company is maintained. Having a good image has an effect on the company's ability to win work and this is one reason why the company manages waste. For this reason, the company ensures environmental and WM performance is reported in their sustainability reports. This is very important when dealing with clients who are sustainability inclined.

#### ***8.4.1.1.4 Concern for the environment***

The concern for the environment as a driver of WM comes as a result of the company's acceptance that the industry has a negative influence on the environment. This realisation coupled with the desire to have a good image or reputation makes the concern for the environment a strong driver of WM. From the environmental policy of the company, the company is keen on *"implementing performance indicators to measure resource use, waste and carbon emissions to demonstrate environmental improvement"*. According to the Sustainability Manager, *"It is an internal policy to do well for the environment"* and this means ensuring all negative environmental impacts are reduced.

Sustainability manager, (construction business) Company A.

The concerns for environmental therefore acts as a driver to ensure the negative impact of waste generation and disposal on the environment makes Company A manage waste.

#### ***8.4.1.1.5 Moral and Social imperatives (Corporate social responsibility)***

To the company, managing waste is also part of their social responsibility. Sustainability forms a greater part of the company's corporate social responsibility (CSR). The sustainability manager suggested that beyond the concerns the company has for the environment, there is the moral concerns to manage waste for the sake of society.

For the company, managing their environmental impact through their activities plays a key role in WM. As deduced from the interview, as a good company, there is the need to ensure the general society is catered for by preventing negative impacts on society and waste management is one of the key aspects.

#### **8.4.1.2 External drivers for Waste management within the company**

External factors driving WM at the corporate level of the company are drivers outside the control of the company and can be grouped into: client demands; the need for benchmarking; and WM legislation (government intervention).

##### ***8.4.1.2.1 Client demands***

Some clients are said to be very interested in environmental performance and this drives WM. The WM document of the company emphasises the role of the client in driving WM. It was identified that a number of their clients demand waste to be managed according to the demands of the EU waste hierarchy where the elimination of waste is the most important option.

Client demands are dynamic and every project might have different demands in relation to WM. According to the sustainability manager, *"Clients are starting to ask some pretty tough questions on our environmental performance, where are we going with our targets, how we go around designing things out, how we go round managing waste, how we go round re-use and recycling and supporting social enterprises that recycle and reuse materials, rather than going to big, bulky suppliers and saying 'it's yours, deal with it.'"* (Sustainability Manager, Company A). As indicated by the Sustainability Manager, the influence of the industry on the environment has become a major issue for most clients who want to be sure the contractors they use do the best for the environment. *"In tenders and in bids, we are more and more regularly asking for specific details and examples of how we done stuff and those examples need to be targeted to a client and targeted to a*

region.” These demands by clients have become a major force driving WM.

#### **8.4.1.2.2 The need for Benchmarking performance**

The company has keen interest in benchmarking their WM best practices. As presented in the environmental policy of the company, the company seeks to publish their environmental performance on projects and benchmark it against other competitors in the industry. Benchmarking as a driver is restated in the company’s WM guidance document. In line with benchmarking of activities, the company from time to time uses example projects to publish best practices or achievements to show their performance. The sustainability manager puts the approach of benchmarking this way:

*“...the whole examples and best practices is a key part of, now, how we do business. We’re encouraging people to do it, sharing best practice and ideas, but also to gather those ideas and put them into work winnings and to demonstrate that we can do this’*

Sustainability manager, (construction business) Company A

The objective of reporting WM and environmental management performance is to demonstrate to the clients and intended clients that the company can contribute to cost savings and the protection of the environment through WM.

At the end of projects, the successes are reported in the sustainability report of the company which is made available to the general public.

#### **8.4.1.2.3 Government legislation**

The environmental policy of the company states that “*complying with applicable environmental legislation, standards and other requirements associated with the industry sectors in which we operate*” is a key requirement of the company. As part of the company’s vision, the policy is to train staff, suppliers and contractors to enhance awareness of the relevant environmental matters. To ensure compliance with environmental legislation is adhered to by the organisation, there is a WM guidance document which has as a purpose “*To ensure all employees are aware of legal, corporate and good practice concerning the management of waste on work sites and at offices.*” The guidance document makes reference to all the relevant WM legislation such as the Waste Framework Directive (WFD); waste hierarchy; use of waste (England and Wales)

Guidance; among others and provides directions on how project teams should approach waste to meet the requirements of all legislation.

The main impact derives from the threat of negative public image resulting from non-compliance.

To ensure such compliance issues are handled, the company relies on the use of competent suppliers who are compliant with legislation and are willing to *take their waste away*. For the size of the company and the size of their projects, the sustainability manager finds it impractical to trail every waste that leaves the project sites so the best way to be compliant with legislation is to ensure that:

### 8.4.2 Drivers for Waste Management - Company B

Summary of the drivers for WM at the corporate level of company B is shown in figure 8.3. Economic considerations, environmental concerns, company image and client demands are the key drivers for managing waste in Company B.

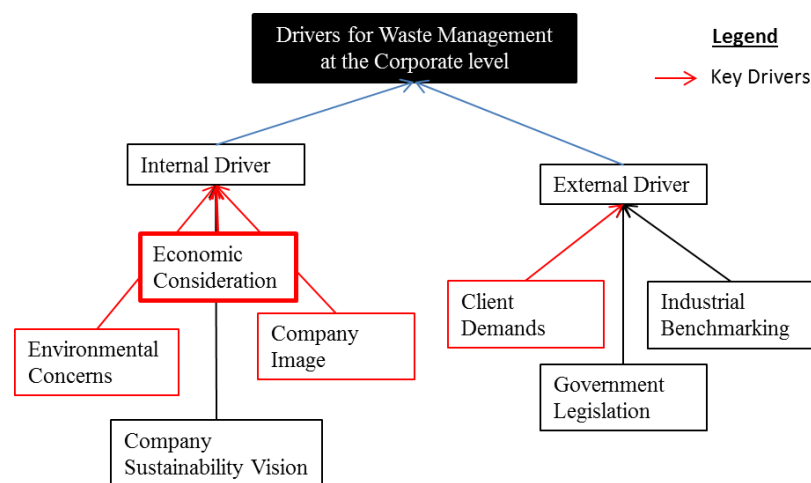


Figure 8. 3: Drivers for Waste Management - Company B

#### 8.4.2.1 Internal drivers for waste management in Company B

As shown in figure 8.3, these internal drivers are cost, company image or reputation, environmental concerns and resource availability.

**8.4.2.1.1 Cost (Economic) considerations**

Economic considerations happen to be the number one driver for WM approaches at the corporate level of company B. The cost of materials (resources) and their impact on the projects drives the resource efficiency vision of the company. In an interview with the senior environmental manager, he recounted the effect of cost on WM: “...So, I’ve got here a figure of £2.4 million spent on the removal of waste from the site in 2013 and that’s only the cost of the skips, so for all of the construction waste movements, there was a total cost of £2.4million and also that cost to the business of waste is much higher.”

(Senior Environmental Manager, Company B)

The impact of cost of waste on the company drives WM at the corporate level as the cost of waste to the business is considered considerably high.

The company as part of efforts to manage waste had been able to reduce the cost of waste removal from their construction sites from a total amount of £3.1million in 2011 to about £2.4million in 2013 and was seeking to drive this cost further down through resource efficiency on projects.

**8.4.2.1.2 Environmental concerns**

Company B recognises waste generation as a negative influence on the environment and seeks to integrate sustainability into their projects to find sustainable solutions for their clients. As expressed in the company’s environmental policy, the company seeks to prevent environmental harm through waste prevention.

*“By pursuing a responsible and proactive attitude to environmental issues (Company A) is committed to minimising any potentially harmful effects of its business activities on the environment and contributing to sustainable development by balancing its business aims with environmental considerations.”*

(Environmental policy, Company B)

Company B is a member of the Ellen MacArthur Foundation’s CE 100 group which focuses on developing a circular economy through a cradle to cradle approach and this according to the senior environmental manager is a commitment to prevent the effect of their activities on the environment and serves as a driver for WM.



#### **8.4.2.1.3 Company Image/Reputation**

As stated in the company's Sustainability Report for 2012, Company B wants *“to be recognised as leaders in sustainable design, construction and property services to help (our) customers create better buildings that last longer and work better.”* To show their commitment to being a responsible company, Company B as a major contractor has signed up to the waste to landfill commitment and this is *“to demonstrate that we're acting responsibly as a company”* (Senior Environmental Manager). Company image/reputation is also cited as one of the main reasons why the company complies with waste legislation as non-compliance gives a negative image and comes with the risk of future business being denied.

#### **8.4.2.2 External drivers for WM approaches**

The most important external drivers for company B are: client demands; benchmarking in the industry; and the need to comply with government legislation. These key drivers are discussed below.

##### **8.4.2.2.1 Client demands**

Client demands serves as one of key drivers for WM in Company B. The company's Environmental Policy as well as Resource Management Plan place emphasis on the client as an integral part of the WM agenda. The needs of clients for BREEAM and other requirements serve as a reason for WM. The interest of client in the records of companies especially prosecution for non-compliance also goes a long way to influence WM strategy of company B. The senior environmental manager summarised the impact of client demands on WM strategy in the extract below:

*“Also, a lot of clients are starting to have high targets for waste diversion from landfill or, in some cases, zero waste to landfill aspirations, so we need to demonstrate that we're working towards that too.”*

(Senior Environmental Manager, Company B)

##### **8.4.2.2.2 Industry benchmarking**

The need to benchmark achievements against competitors serves as another motivation to do more with WM as this can also have an influence on their ability to win bids (especially from clients who are sustainability/environmentally inclined). As part of industry

benchmarking, the company has adopted principles from the Waste Resources Action Programme (WRAP) an industrywide programme towards WM. Industry commitments such as ‘Halving Waste to Landfill’ push the company to sustainably manage waste and prevent materials from getting to the landfill.

Through benchmarking, company B seeks to be able to make inputs by way of recommendations to their clients on waste reduction.

#### **8.4.2.2.3 Government Legislation**

Compliance with legislation is an integral part of the WM approaches of company B. The environmental policy of the company proposes that the company will *comply and where possible, exceed legal and other requirements to which it subscribes, in relation to environmental aspects* (Company B, environmental policy). The Resource Management Plan of the company also makes the declaration for legal compliance as a major aspect of WM.

To ensure the company is compliant with legislation, environmental audits are conducted from time to time to pick out non-compliant issues. These audits conducted by the senior environmental manager, picks up issues such as documentation in terms of waste transfer notes, ensuring receivers of waste have the required permits and carriers registrations.

As explained by the senior environmental manager, legislation as a driver plays a secondary role due to the effects prosecution for non-compliance can have on their activities. In his own words:

*“If you are prosecuted as a company, there’s a massive black mark on your record, which you then have to report in most prequals and tenders that you send to prospective clients, so the prospective clients will say ‘have you been prosecuted at all in the past five years?’ It’s a companywide thing as well, so if one site causes a pollution incident, or a breach of waste legislation, then it’s a black mark for the whole of the company, so it’s important that every site is compliant. So, it’s primarily because of the risk of public perception and winning future work.”*

Senior Environmental Manager, Company B

### 8.4.3 Drivers for Waste Management - Company C

A summary of the drivers for WM in company C is shown in figure 8.4. Economic consideration and government legislation are identified to be the key drivers.

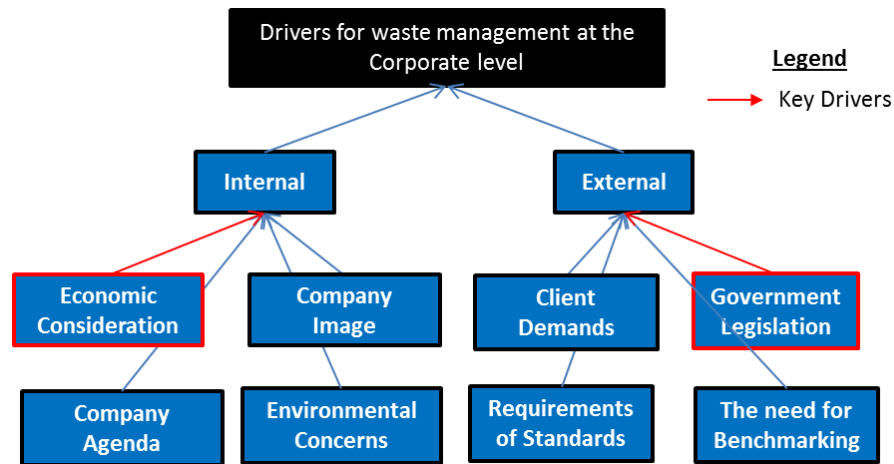


Figure 8. 4: Drivers for waste management Company C

#### 8.4.3.1 Internal drivers for WM

Internal factors driving WM approaches at the corporate level of the company are: economic considerations; the company agenda to be best of their class; company image; and concern for the environment

##### 8.4.3.1.1 Cost consideration

As explained by the company's environmental manager, the company at the group level compares their turnover against the cost of waste and the need to reduce this serves as a driver to manage waste. Though other factors such as legal compliance and company image push for WM, the company sees cost considerations as a big push for WM. The environmental manager explains cost as a driver this way: *"In construction, the legal and the finance are equal. Yes, we have to be legal compliant, and providing that one ticks the boxes, the next one is, definitely, finance."*

It was gathered that cost driving WM stems from the company recognising the negative impact of WM on project costs such as: increase in cost due to disposal fees for mixed waste; cost of buying more materials to replace wasted resources; and cost of compliance. Removal cost was cited as the main contributor to the cost of WM and that is a reason why

waste reduction was the major strategy of the company. The main work section with cost savings was identified to be excavation works.

#### **8.4.3.1.2 Company's Agenda**

The company has an agenda to be *best in their class*. Though cost and compliance happens to be major drivers for WM, the company's own agenda to be a good contractor drives WM and makes Company C put in effort towards ensuring the reduction of waste. *"We're a good, responsible contractor and, being legally compliant is important to us, we want to be the best in class, so we look for best practice. So, we do that regardless of site WM regulations, regardless of ISO 14001 because that is what we do."* The need to show that the company is a good one and takes care of the environment makes company agenda a driver for WM.

#### **8.4.3.1.3 Concerns for the environment**

The concern for the environment and the need to ensure the protection of the environment and also the environmental benefits of WM drive the activities of the company. As explained by the environmental manager: *"obviously, the environmental benefits, in terms of resource efficiency. If you're re-using soils on site, rather than digging them and sending them away to be disposed of because they're contaminated and then you bought in a whole load of new material, it just speaks for itself. So, in terms of resource efficiency and soils, aggregates, things like that, where we can, we crush bricks and concrete and re-use that as hard core, rather than importing stuff."*

From this perspective, it became obvious that the environmental benefits of WM acts as a good driver for WM at the corporate level of the company though site or projects teams may only see things through the eyes of cost savings.

#### **8.4.3.1.4 Company Image**

According to the environmental manager, a good reputation for WM helps the company to win works by getting concerned clients on the side of the company. The environmental manager simplifies the issue of image as a driver in the extract below: *"We're a big company and money is a cost, but reputation and winning work and getting the clients on side, that's what's more important, ... (When) you get a bad reputation, you don't get any work, it's as simple as that and a lot of our work is in the public sector, the government is one of the biggest employers."* She went on to give examples of a number of projects the

company was able to win (repeat jobs) due to the good image the company had for their performance. From the interview, it was gathered that reputation or image as a driver of WM, depends to a large extent on the type of clients a company deals with.

#### **8.4.3.2 External Drivers of WM strategy**

Four main external factors were captured to drive the WM strategy of Company C. These drivers are: government legislation; client demands; industry benchmarking; and the requirements of standards.

##### **8.4.3.2.1 Legislative demands**

As the environmental manager explained, non-compliance is one of the biggest risks to the company. Consequently, every effort is made to be complaint at every time. The environmental policy of the company also recognises legislation as key in their environmental and WM efforts. As reported in the environmental policy, the company will *“identify and comply with all legislation, standards and codes of practice, which are relevant to our business activities”* (Environmental Policy, Company C). For this reason, the company ensures the site teams know *what they have to do*. According to the environmental manager: *“It’s our biggest risk, but I think it’s one of those things that we are particularly good at in terms of making sure that, right down at project level, the guys know what they have to do. They know the basics, it’s making them aware of the things that they need to be aware of. We don’t need them to be environmental specialists, just understand where there’s an issue.*

As she further explained, *“Finance would not take over legal compliance”* when it comes to managing waste (Environmental Manager).

##### **8.4.3.2.2 Requirements of Standards**

The need to meet the demands of standards and support systems either as a demand of the client or as part of the company’s membership of external bodies drives waste. Requirements of standards such as ISO 14001 were cited as a driver for waste management.

##### **8.4.3.2.3 Client demands**

Client demands drive the company to adopt sustainable WM practices as these helps to give the company a good image. As explained by the environmental manage, the company

wants the client to see them as a good company: *“You want to be seen as a company that keeps things clean and does it properly and the client sees what you do on site.”* The client, as the environmental manager explained, sometimes may want to have BREEAM ratings or may impose the code for sustainable homes on the contractor and these come with particular demands. So as a company, WM strategies have been tailored to meet such demands when the client requests for them.

#### **8.4.3.2.4 Industry Benchmarking**

Being in a very competitive industry, the company wants to do better than their competitors and this to a large extent affects company strategies which include WM strategy. When questioned whether other external factors aside the law influence the company’s WM strategy, the environmental manager explained that industrial benchmarking affects the WM strategies. *“We report to UKCG, our waste figures are recorded, so we’re compared against the industry. So, for group it’s about figures, within group, each company their KPIs are reported; cost of waste against turnover, so the driver for them is to reduce the waste they produce by keeping the cost down.”*

For the company (that seeks to be the best in their class), the need to ensure the company performs better than their competitors during such comparisons pushes Company C to put in effort into WM.

#### **8.4.4 Drivers for Waste Management - Company D**

Summary of drivers for WM at the corporate level of company D is shown in the figure 8.5. As indicated on the figure, economic considerations, company image and client demands are the key drivers for corporate level WM.

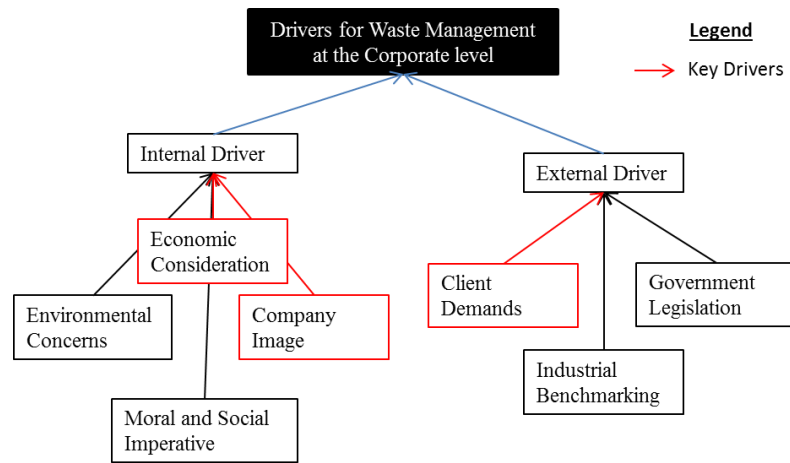


Figure 8. 5 Drivers for waste management Company D

#### 8.4.4.1 Internal Drivers for WM

These drivers were identified as: economic consideration; the image or reputation of the; concerns for the environment; and the moral or social imperative to manage waste.

##### 8.4.4.1.1 *Economic Consideration*

Cost of waste generation is the second most important driver of the waste strategy of the company. Company D spends about 0.5% of their construction turnover on waste and this high cost serves as a driver to make in strategies to manage waste. Sources of cost considered were: cost of materials in the waste, the cost of hiring skips, transportation of waste and the charges paid at the landfill. According to the Environmental Manager, “*we also spend quite a lot of money on our WM and that’s usually in the region of about half a million pounds, depending on how much work we’ve got going on, which is about half a per cent of our construction turnover, which is quite a big cost, so we’ll keep to reducing cost, just to make us more efficient anyway - it makes good business sense.*”

To make good ‘business sense’, the company ensures the cost of waste disposal as a result of landfill tax is reduced by reducing, reusing or recycling waste instead of landfilling where charges are very high.

##### 8.4.4.1.2 *Company Image*

Company image is important for two main reasons: to show to the general public that the company is responsible; and to serve as a means to win contracts (from clients who are environmentally inclined). To ensure the company’s image is kept in check, the company subscribes to a number of standards. The environmental policy recognises

reputation/image as a key part of the company's business. *"Our reputation is tested every day by the personal standards set by all those employed in Company D. Our certification under ISO 14001: 2004 is an important component in maintaining our reputation and position as the customers' first choice."* The Environmental Manager stressed how important image is to the company in the following extract. *"Are we concerned about our image? Yes, we definitely are concerned about our image. We're very keen on being a responsible contractor and we subscribe to the Constructors Scheme, so they can do audits as well."*

#### **8.4.4.1.3 Concern for the Environment**

The company has a strong commitment to environmental management (protection) and this to a large extent drives the waste strategy of the company. This can be seen in the company's investment in environmental management system (EMS) and commitments made in the environmental policy. The environmental policy of the company states: *"we will ensure that procedures are appropriate to the nature, scale and environmental aspects of our operations in offices and the projects we design, develop and construct."* A key environmental objective as stated in the environmental policy is: *"to operate in accordance with the Company's environmental procedures, to achieve our defined environmental targets and prevent pollution"* (Group environmental policy Company D, 2014). The Environmental Policy of the company also recognises the limited landfill space in the UK as an environmental concern and suggests best practices to reduce the amount of waste going to landfill.

#### **8.4.4.1.4 Moral and social imperative**

*"I think, for us, moral and social imperatives drive us to do more than the legal requirements because we want to be the contractor that's seen as the go to people, that's where we'd like to place ourselves."* (Environmental Manager, Company D). According to the environmental manager's comments, among all other things, the company sees it as a moral obligation to take care of the environment and this drives waste management. This social and moral concern to some degree also converts into financial gains for the company as waste can be sold as a resource once 'people' accept the company as a good one environmentally.



#### 8.4.4.2 External Drivers

The most important external driver for WM in the company is client demands in for WM. Other external drivers include: government legislation; and benchmarking in the industry.

##### 8.4.4.2.1 Client demands

Though the company subscribes to various environmental standards and seek to be compliant with government legislation at all times, demands of clients appears to be the strongest driver for the corporate waste strategy. According to the environmental manager, the company works with a lot of big high street brands and these clients/customers set the requirements for WM. *“They set requirements like 100 per cent recycling, for instance, and some of them set waste targets, waste production targets in general. Some of them like to use BREEAM, so we use the targets that are set out in BREEAM and most of our monitoring and tracking on projects relates to meeting the targets that are set by the customer”* (Environmental Manager, Company D).

Company D deals with clients who want to be able to put out a CSR report annually stating that the main contractors for their projects delivered x, y and z in terms of environment and waste. These clients are more interested in what their customers think of them and will put in all measures to ensure contractors meet their required standards and targets.

##### 8.4.4.2.2 Benchmarking

Due to the level of competition within the industry, especially with recent trends towards environmentalism, sustainability and being green, the company sees every project as an opportunity to benchmark their activities against competitors. The environmental manager suggested that benchmarking (competition) is a key driver of their activities when she stated: *“In terms of our organisational structure, I would say, at board level, we’re interested in overall project figures meeting customer targets and being able to compete with other contractors and say ‘we’re actually doing better than you do’ kind of thing”*. As part of benchmarking, the company seeks to, *“Whenever practical meet or exceed industry good practice on environmental and sustainability issues”* (Environmental Policy). Beating the industry standards means being industry leaders and for the company, that is a big driver to ensure waste is managed.

#### **8.4.4.2.3 Legislation**

Though legal compliance, is not the number one driver of WM (according to the environmental manager), the company makes every effort to ensure compliance with all waste legislation is achieved. Both the Environmental Policy and Waste Standard of the company make references to legal compliance as an essential part of WM. The company also ensures all duty of care requirements is duly followed. The environmental manager of the company, in talking about the impact of legislation on WM suggested that, the company is interested in protecting the environment and this falls in line with government legislation and policy directives.

The Waste Standard Document of the company recognises the effects of non-compliance such as: prosecution; fines; and loss of reputation as a major concern for the company and the need to be compliant at all times. The company as a result of these have put in place *failsafe points* to ensure every issue with non-compliance is identified before it escalates.

## **8.5 APPROACHES TO WASTE MANAGEMENT AT THE CORPORATE LEVEL**

The vision, values and drivers of WM in the various companies determine approaches determined at the corporate level for managing waste. These approaches are discussed below considering the three main project stages: design; procurement; and construction.

### **8.5.1 Approaches at the corporate level of Company A**

As shown in figure 8.6, approaches to waste management in Company A include: designing out waste; supply chain arrangements to select sub-contractors with good waste management credentials; and reliance on senior management to partner with sub-contractors to meet targets for WM.

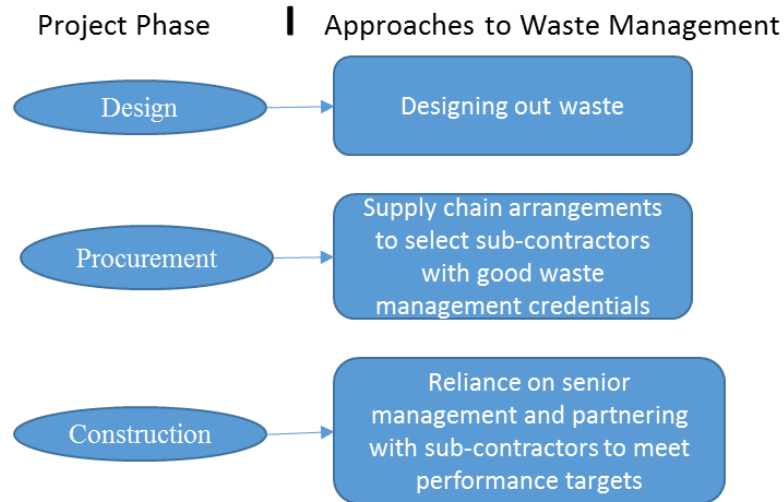


Figure 8. 6 Approaches to waste management in Company A

#### 8.5.1.1 Approaches at the Design Stage

As a design and build firm, the approach to WM at the design stage encompasses the principle of designing out waste. This approach ensures sustainable designs are considered. The emphasis of the design process with respect to WM is on waste reduction as the company recognises design as having a key part to play in the WM process. For design and build contracts, the approach adopted by the company is to apply suitable design options to ensure reduction of waste during construction, and to incorporate planning for waste reuse where possible.

#### 8.5.1.2 Approaches at the Procurement stage

At the procurement stage, the company's approach to WM concentrates on supply chain arrangements to select *"the right teams for projects who have good credentials for environment or WM"*. Based on the supply chain arrangements, the company seeks to ensure only the most qualified sub-contractors who buy into their idea of sustainability are used. The company uses package managers who have a duty to work with procurement teams to ensure the supply chain use the *preferred supply list*. The preferred supply list of sub-contractors is developed with environmental and WM performance as part of the qualification criteria.

The company has a number of filters to ensure sub-contractors who are not environmentally compliant or do not share in the company's policy on WM are not brought onto site. This approach to WM was expressed in the company's environmental policy as well as guidance on WM. The sustainability manager for construction businesses of the company explained this approach as follows:

*“we just need to be making sure that we're working with our subbies we trust, we recognise won't cut corners to achieve that. So, again, that comes back to, we've got to make sure it's a legal requirement, we've got to make sure we know who we're working with at our supply chain, so at a strategic level, we've got our targets, we've got our preferred group of suppliers”*

### **8.5.1.3 Approaches at the construction stage**

At the construction phase of projects, WM within the company takes two approaches. The first approach involves setting targets and implementing performance indicators to measure resource use, waste and carbon emissions. The achievement of these targets requires working with the company's staff, customers (clients) and the supply chain to promote best practices. With this approach, the company gives senior management on projects the responsibility to implement the policy and targets of the company. For this reason, the company has sustainability teams overseeing all aspects of resource and material usage as well as making decisions on sustainable approaches to doing things.

The second approach involves collaboration between the company and its sub-contractors to ensure the targets for WM are met on projects. The company focuses on this approach due to the realisation that the sub-contractors play a crucial role in the company achieving its sustainability goals and aims.

### **8.5.2 Approaches at the Corporate Level of Company B**

Approaches to waste management at the corporate level of Company B can be summarised into: resource efficiency measures at the design stage; responsible sourcing at the procurement stage; and the use of resource management plans at the construction stage. This is shown in figure

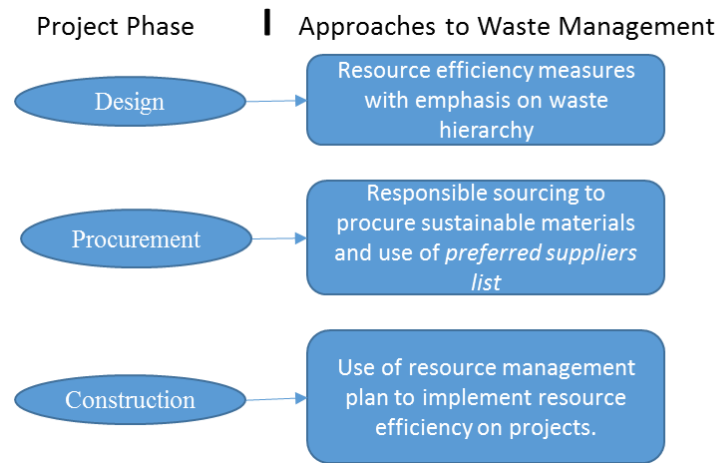


Figure 8. 7: Approaches to waste management Company B

### 8.5.2.1 Approaches at the design stage

As a company involved in design, at the corporate level, design stage WM approaches concentrate on designer resource management activities that impact on resources, reduce material consumption and waste reduction. This include: design for reuse of demolition materials; design for use of cut and fill for soils; and use of simple design form and layout to reduce waste generation. The approaches at the design stage emphasizes on the waste hierarchy as the best means to ensure waste is sustainably managed by design. At the end of the design process, all such activities are recorded to serve as the basis for planning WM at the construction phase.

### 8.5.2.2 Approaches at the procurement stage

Approaches to WM at the procurement stage of projects in Company B take the form of ‘*responsible sourcing*’ which is aimed at ensuring only sustainable materials are procured using suppliers that make it to the company’s ‘*preferred suppliers list*’. This list is developed as part of a planning managerial activity which seeks to evaluate the suppliers used by the company on a number of criteria with sustainability credentials as a major proxy. The company from time to time evaluates their suppliers and well performing companies make it to the preferred supplier list which is the first point of call for procurement purposes. As part of the procurement approaches to ensure resource efficiency, the company also ensures only specified materials are delivered to project sites. The senior environmental manager of the company explained the procurement approach and preferred suppliers as follows:

*“We’ve got our preferred suppliers and, at a contract level, our teams will let the packages of work, depending on the type and nature of the construction project to building, or civils, or whatever and they will go to the suppliers on our list and that’s a multitude of different criteria they’ve got to fit from, payment terms, credibility, solvency, business kind of performance, their ethics, how they operate if their safety standards are in line with our and all that kind of stuff, as well as then their sustainability credentials, so that’s how they get on our supply list.”*

### **8.5.2.3 Approaches at the construction stage**

Approaches developed at the corporate level for WM at the construction stage of projects concentrate on the use of resource management plans to implement resource efficiency measures on projects. This approach involves all parties concerned with the project at an early stage to plan and prevent as much waste as possible. Approach to construction stage WM also involves the use of the waste hierarchy to put measures in place to reduce the estimated waste for the construction phase, reuse where possible, recycle and recover materials. For this reason, objectives are set for each projects tied to targets to be achieved depending on the site and project characteristics. Achieving targets on projects also involve emphasis on handling materials on site to prevent waste generation.

### **8.5.3 Approaches at the Corporate Level of Company C**

Figure 8.8 summarises the approaches to manage waste at the corporate level of Company C which includes: design to reduce waste by influencing the choice of clients; responsible sourcing and use of environmentally friendly supply chain; adoption on best practices on site.

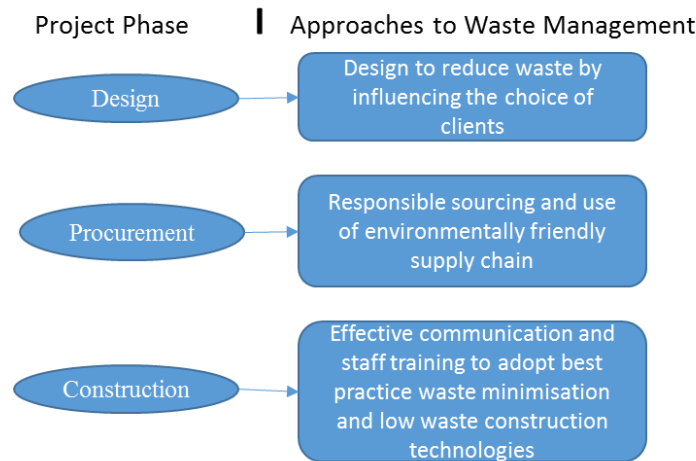


Figure 8. 8 Approaches to waste management at the corporate level of Company C

### 8.5.3.1 Approaches at the design stage

At every stage of their projects, the approach adopted by Company C is, first to seek avenues to reduce or minimise waste to save on cost. At the design stage of their projects, this entails the design team seeking avenues to reduce waste by the design solutions they provide. As stated in the environmental policy of the company, the company “*seeks to influence the choice of their clients by proposing solutions that will benefit the environment*” (Environmental Policy, Company C). The approach at the design stage also covers the specification of: reusable materials; and low waste technologies such as off-site manufacturing, modular construction, and prefabrication materials which poses less environmental harm/ waste generation potential.

For projects where the company is part of the design process, the company seeks to ensure their designers adopt the best techniques available to reduce waste. The company also requires their sub-contractors to consider ways of minimising the quantities of waste generated through their design initiatives as reported in the site WM Planning Document for sub-contractors.

### 8.5.3.2 Approaches at the Procurement stage

At the procurement stages of the company’s projects, the approach to WM is to ensure responsible sourcing process where materials and or services with less environmental impacts are procured. Be it a supplier of materials or a sub-contractor on the projects run

by Company C, the approach to WM is to ensure the company used are compliant with legislation and also have good environmental management credentials.

The company through their procurement arrangements also ensures the WM contractors they use have good WM credentials. As explained by the environmental manager of the company, “we look to use best practice in terms of the WM contractors that we use and make sure that they remain legally compliant”.

### 8.5.3.3 Approaches at the Construction Stage

The approach to WM during the construction phase of projects takes the form of managerial guidance from the company to the site teams. This includes helping site teams to know which areas to consider to ensure waste minimisation is achieved. As explained by the Environmental Manager for the company “it’s working with the site team, to identify environmental aspects, the impacts, things that need managing and give them general advice on waste and good site management practices and some managers need more support than others, so it’s about giving the training and support when it’s needed.”

The approaches to manage waste during the construction phase of projects can be simplified based on the major waste stream as shown in the figure below.

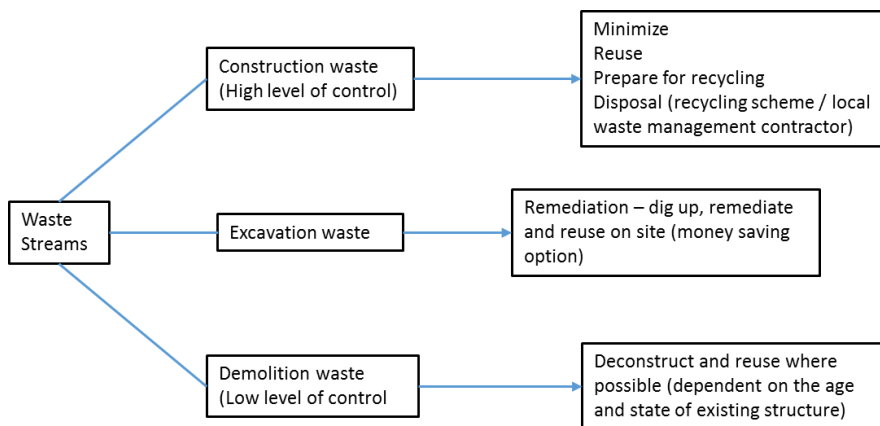


Figure 8. 9 Approaches to waste management at the project phase in Company B

As shown in the figure above, the company acknowledges there is a higher level of control for construction waste (new works) as compared to demolition waste. The company’s environmental manager explained the approaches this way:



*“Construction waste is the one that we can control, as a site team, in terms of how we manage it, so we can minimise where we can, we can use what we can on site, we can be selective about the routes that we choose, whether we go to a recycling scheme, whether we go to a local WM contractor, so that is within the control of the site team.”*

From her response, it is evident that the approach to WM at the construction phase is to make site teams look for avenues to reduce, reuse, recycle or dispose of construction waste. The central environmental manager also suggested that excavation works provides the company the avenue to save money by adopting best practices: *“Excavation works, groundworks - there’s lots of money to be saved by doing remediation - we’ve done jobs where we’ve dug up contaminated ground, we’ve remediated on site, we’ve re-used it, but that sort of exercise needs forward planning.”* So excavation presents the opportunity for the company to pursue material reuse through remediation where possible.

#### **8.5.4 Approaches at the Corporate Level of Company D**

As explained by the company’s environmental manager, the approach of the company is to manage the processes/phases (design, planning and construction) when the company is involved. The company’s approach mainly takes into consideration the management and monitoring of the activities of their sub-contractors or consultants throughout the phases to ensure best practices are applied. Summary of the company’s approaches to WM at the corporate level are shown in the figure 8.10.

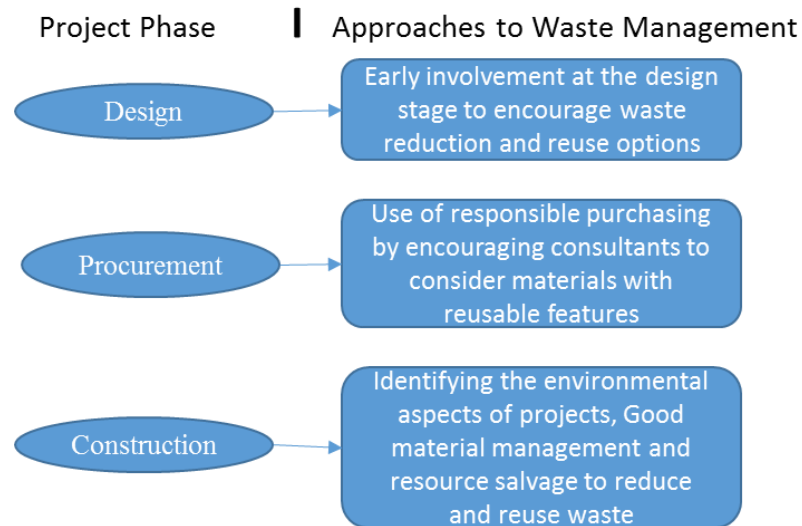


Figure 8. 10: Approaches to waste management at the corporate level of Company

#### 8.5.4.1 Approaches at the design stage

The approach to WM at the design stage promotes early design involvement. As the company is usually not in charge of the design of projects, the company's approach at this stage is to be involved early on in the project to ensure inputs can be made towards waste. Like other stages of their projects, the company encourages consultants to "*identify the environmental aspects of developments and construction process for individual sites and put in measures to reduce such impacts*" (Group environmental policy).

#### 8.5.4.2 Approaches at the procurement stage

According to the environmental manager, the approach for WM at the procurement stage ensures the company only deals with firms that are compliant with legislation, and takes care of all arrangements for provision of skips and waste transfer stations. In terms of material procurement the company approaches WM through the principle of *responsible purchasing*. Responsible purchasing as used by the company refers to the practice of encouraging consultants to specify, where commercially justified, materials and technologies with reduced environmental and social impacts. Purchasing of reusable materials was encouraged (where economically feasible).

### 8.5.4.3 WM approaches at the construction stage

Approaches at the construction stage of projects take the form of managing the activities of their sub-contractors to ensure waste issues are well catered for. There is also monitoring and supervision of environmental and WM issues by the company's environmental manager who ensures site teams get the necessary assistance with waste issues. The company pursues a best practice approach to WM at the construction stage which is mainly tailored towards client demands. With reference to the waste hierarchy, the company's approach is to ensure majority of efforts are targeted at waste reduction and reuse. These are promoted through best practices tool box talks. Some of the best practices promoted by the company are: *'early design involvement, off site construction, good materials management on site and resource salvage for use by community groups or social enterprises'*. (Waste standard document).

## 8.6 STRATEGIES FOR WM AT THE CORPORATE LEVEL

To implement the approaches discussed above on projects, a number of strategies are adopted or designed by the companies. These are categorized into strategies for: WM planning; governance WM; outsourcing of WM responsibilities; training and education; systems for WM; and WM monitoring . The strategies at the corporate level of the companies for managing waste are discussed below.

### 8.6.1 Strategies for WM at the corporate level in Company A

Strategies for WM in Company A can be summarised below.

#### 8.6.1.1 Planning for waste management

A summary of the strategy used for WM planning in company A is shown in the figure below.

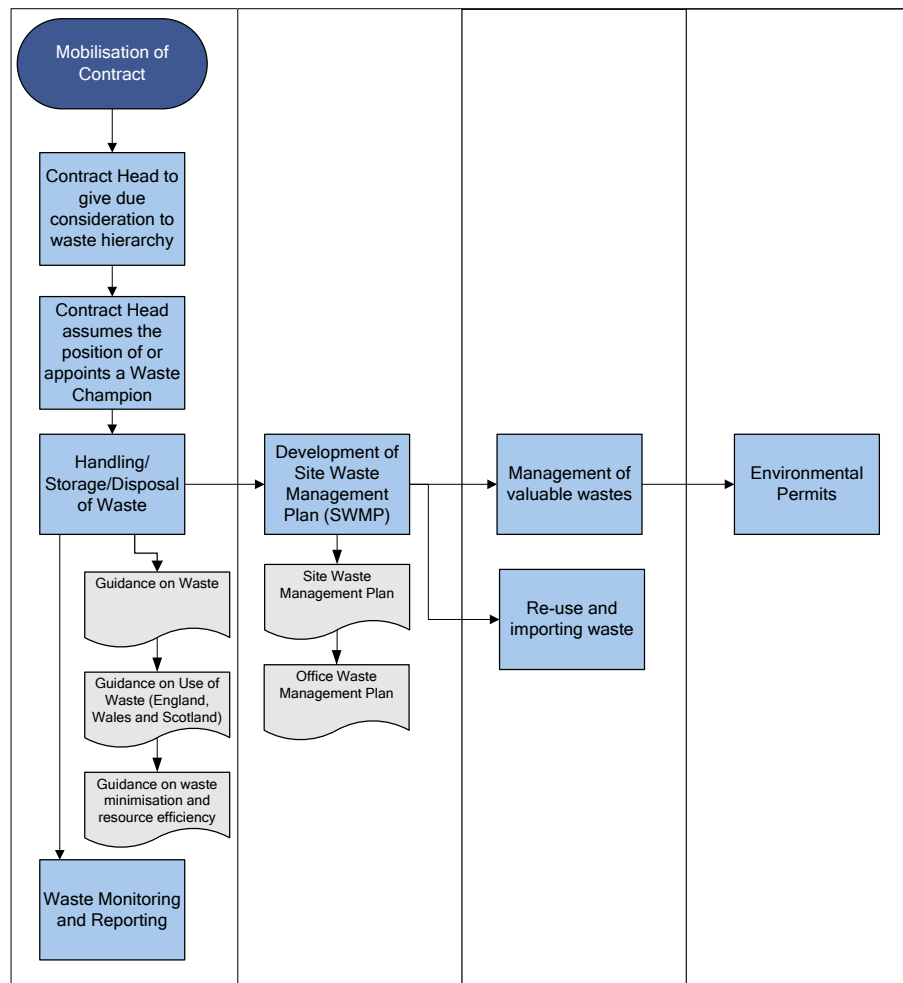


Figure 8. 11 Procedure and flow of responsibilities for WM on projects

(Source WM procedure, Company A)

As figure 8.11 shows, planning for WM in company A follows a template designed at the corporate level. The company has a clearly defined route regarding WM at the project level and this helps to guide the practices on site. Planning for WM on projects begin from the mobilisation stage of projects/contracts where the person or people in charge of waste are selected for that particular project. After the selection of the persons in charge of waste for the company, a strategy for project level WM is determined based on site characteristics as well as project features or factors.

### 8.6.1.2 Outsourcing

As part of the company's WM strategy, activities such as waste collection, transfer and disposal may be outsourced. For the purposes of collecting, transferring and disposing waste in company A, two main strategies are adopted for outsourcing:

- a. The use of a WM sub-contractor (logistics company) to deal entirely with all WM

activities on the project; and

- b. Employing a waste broker to provide skips into which all waste must be segregated by the site team and carried away by the company.

As explained by the Sustainability Manager for the Company, with the first option, the logistics company will handle all WM activities including on site sorting or segregation of waste whereas the second option is more of a hybrid between the waste broker and the workers of Company A. The choice of strategy for outsourcing WM is dependent on project factors.

#### **8.6.1.3 WM Monitoring Strategies**

To monitor and measure the performance of the WM practices, the company ensures all WM activities are captured into an integrated management system (IMS) which has the set targets as well as the approach for the site to help meet those targets, and serves as the basis for monitoring performance. As spelt out in the company's WM guide, the company: *'sets annual targets for waste recycling, which sites are expected to meet or exceed whenever possible. To monitor progress against these targets, every site must complete the Waste Targets and Monitoring Form as part of its Site WM Plan on a monthly basis'*.

#### **WM Guide, Company A**

#### **8.6.1.4 Governance strategies for Waste Management**

At the corporate level, company A recognises senior management as responsible for implementing the environmental/waste policy. The highest role responsible for WM is the chief sustainability officer who heads the sustainability teams responsible for setting sustainability targets. These teams are in charge of deciding WM strategies for the company which are then transferred unto their projects.

The sustainability manager explained how this governance strategy affects the project phase in the text below:

*... 'typically, there'll be a project manager, or a project lead, there'll be a commercial team, there'll be a design team and there'll be an engineering operations team, which maybe a handful of people, and they, between them, will be managing everything that happens on site on an operational basis'. He further explained, ... one of their roles will*

*be to co-ordinate the waste, so we'll have a waste champion on site and their role will be to make sure that the waste contractor is appointed and that they know who it is and how the waste will be dealt with".*

This governance strategy is defined at the corporate level of the Company and passed on to all projects of the company. The hierarchy for WM at the corporate level of Company A is shown in the figure below.

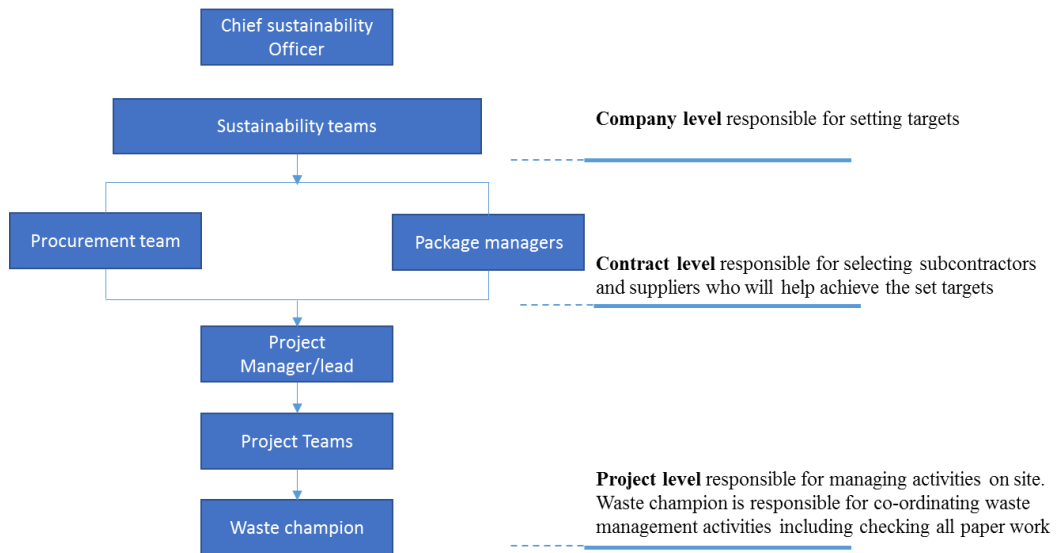


Figure 8. 12: Waste management governance structure - Company A

#### 8.6.1.5 Training and education

Training and education on WM is the responsibility of the project management teams. The company has tool box talks and inductions for site teams and this serves as the main bases for training and education. The waste minimization and efficiency guidance notes served as part of the documents for training.

#### 8.6.1.6 Waste management system

Company A has an integrated waste management system (IMS) that helps with the management of waste. This system is used purposely for storing information which forms the basis for monitoring.

#### 8.6.1.7 Documentation for waste management

Company A has four main documents which serve as sources of information and aid in the establishment and implementation of WM strategy. The sustainability manager suggested that the documents are intended to help site teams “*understand where waste may be eliminated, types of waste, and appropriate actions taken to reuse, remanufacture, recover*

*and recycle materials before disposal to landfill is considered.”* The four main documents are: the environmental policy; the waste minimization and resource efficiency (guidance notes); the WM guidance; and the WM procedure document. A summary of each document is produced below.

#### ***8.6.1.7.1 The Environmental Policy***

The environmental policy document of the company forms the overarching document concerning the management of the environment and waste. This one page document makes a clear statement on the position of the company concerning waste and sets out the company’s strategic commitment to the environment. It supports the company’s overall sustainability policy and describes the responsibility towards the environment. The means to achieve the sustainability policy of the company as expressed in the policy covers: the effective implementation of environmental standards (ISO 14001 2004); setting of targets for environmental management and pollution prevention covering resource use, waste and carbon emissions; regard for legislation; collaborating with supply chain to achieve the set targets; and the benchmarking of activities against other players in the industry.

#### ***8.6.1.7.2 The Waste Minimization and resource efficiency guidance notes***

This document contains the best practices towards waste minimisation and efficient management of resources on project sites. The purpose of this document is to ensure all sites operate in line with best practices of the company and meets the targets for waste and resource use. This document sets out the step by step approach to WM on construction sites and spells out the practices to avoid in ensuring resources are efficiently utilised on construction sites. This document also sets the criteria for ensuring efficient use of other resources such as electricity and fuel on construction sites.

#### ***8.6.1.7.3 The waste management guidance***

The WM guidance document provides information on the control of waste generated on all project sites. It is designed to ensure that all employees are aware of the legal, corporate and good practices concerning the management of waste, and explains legislation regarding WM highlighting aspects site teams need to pay attention to.

#### ***8.6.1.7.4 The waste management procedure***

The WM procedure document details the procedure to be adopted for WM on projects from the mobilisation stage through to the execution of projects. This document serves the

purpose of identifying the controls for handling, storage and disposal of controlled waste (including hazardous waste) produced on the company's construction sites. The document defines the various aspects of WM as well as all key terms in legislation regarding WM. At the same time, it details the procedure for a number of activities:

- a. Management of valuable waste products procedure;
- b. Re-use and importing of waste procedure;
- c. Site WM plans procedure; and
- d. Environmental permits – waste procedure.

### **8.6.2 Strategies for WM at the corporate level in Company B**

The strategies for WM at the corporate level of Company B are discussed in this section.

#### **8.6.2.1 Planning for waste management**

At the corporate level of company B, planning for WM takes the form of an 'all hands on deck' strategy where all parties take part in the planning for WM. A Project Resource Management Plan (PRMP) forms the main basis for planning WM on projects which is to be filled and signed by the project/resource manager and the construction director or manager on projects. According to the company, this plan after preparation must be displayed on the site environmental notice board and includes requirements for site WM plans. The PRMP sets the environmental targets for projects and details requirements for project phase and records client and designer resource management planning decisions.

As part of the planning strategy, the PRMP details the WM roles and responsibilities for the client representative, project manager or principal contractor, the resource manager, and regional environmental representatives.

#### **8.6.2.2 Governance of WM**

The governance strategy for company B considers: the group level; and the project level. There is an environmental team at group level which deals with environmental or WM issues of the company, and a project level team that deals with waste and environment at the project level. A summary of the responsibilities for the groups is shown in figure 8.13



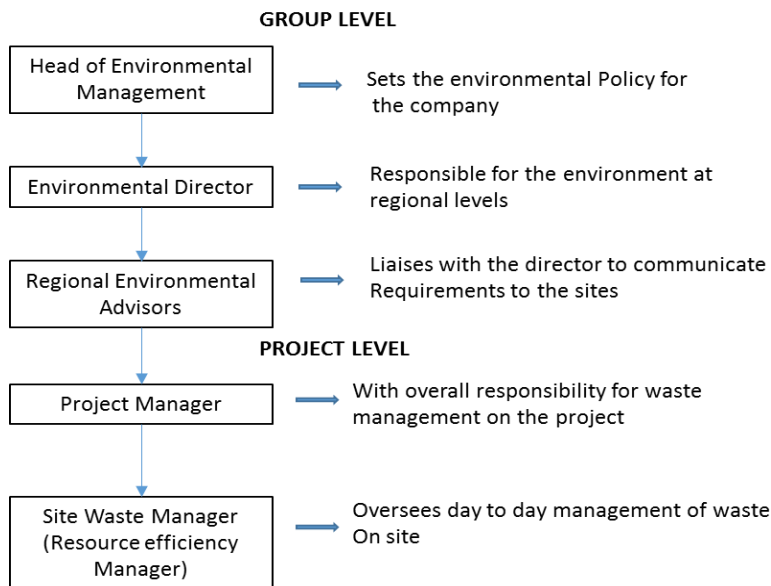


Figure 8. 13: Waste management governance structure - Company B

As shown in the figure above, the overall responsibility for WM in company B lies with the head of environmental management in charge of the company's environmental policy which covers WM. To help with operations within the group, company B is divided into seven regions and each region has a director who together with regional advisors (environment) communicates waste and environmental decisions to project sites. At the project level, the project manager has overall responsibility but has the liberty to delegate that responsibility to a member of the site team in the capacity of a site waste manager or a resource efficiency manager. The resource efficiency manager or site waste manager then sees to the day-to-day management of waste on site with assistance from the environmental advisor for that particular region.

#### 8.6.2.3 Outsourcing of WM responsibilities

WM strategies developed at the corporate level of the company also take into consideration outsourcing of WM responsibilities as and when necessary.

#### 8.6.2.4 Training and education for waste management

According to the corporate strategy of the company, training and education on WM is the duty of the project management teams who organise inductions and tool box talks as and when required. There are also signage and posters displayed on project sites to serve as aid memoir for site teams concerning WM.

### 8.6.2.5 Monitoring of waste management

For monitoring WM activities within the company, Company B has an in-house electronic (Smart) system which serves as the main tool for keeping a check on WM within the company. This system according to the senior environmental manager helps the company to be able to check the progress with WM at any point of a project. The system also helps regional environmental managers or advisors to monitor and advice project teams on the environmental or WM performance of projects. The senior environmental manager described the monitoring system as the main tool for also monitoring compliance:

*“Management system, I mentioned earlier about internal audits, so we conduct internal audits to ensure legal compliance, which include waste, and going back to the external audit, it’s making sure that the online system has the waste transfer notes so that they can be audited.”*

### 8.6.2.6 Waste management system

According to the south east environmental manager, the company has a system for WM which helps in planning and monitoring WM also helps in the planning for other projects:

*“the System (name withheld) has been running now for just over three years, so three years gives you sufficient data to gauge a pattern. We can go in and tell you, at a type of project, for instance, if we’re building schools, this is the split between the different EWC codes, what percentage they were, and then if you’re building a superstore, like Morrisons - this is what it’s gonna be - and that type of thing.”*

### 8.6.2.7 Documentation for waste management

Five documents contribute to the development of WM strategy in Company B. These documents are the: Project Resource Management Plan; Sustainability Report; Register of Regulations; Environmental Policy; and Design Influence on Reducing Waste. The documents contribute in a number of ways to WM. Summaries of the documents are given below.

#### 8.6.2.7.1 The Environment Policy

The company has a one page Environmental Policy of the company, and this gives the company’s stance on WM. As explained by the senior environmental advisor for the company, the company has no specific WM policy document but requirements for WM are all laid down in the environmental policy. *“We don’t have a waste management policy as*

*such; I've just got the environmental policy here, which is publicly available. So, what the environmental policy does, it says reduce waste production and divert waste away from landfill by promoting resource efficiency recycling and the use of recycling materials. So, that's effectively our policy on WM - to reduce waste".* The environmental policy forms the main basis on which WM is implemented in the company. As stated in the environmental policy, the company seeks to meet and where possible exceed legal and other industry requirements for environmental matters.

#### **8.6.2.7.2 Project Resource Management Plan**

The company, since the scraping of the site WM plans legislation as a legal requirement, has resorted to the use of the Resource Management Plans as the basis for planning and managing WM. This document forms the basis for setting targets for projects and putting in place measures to ensure those targets are met on all projects. The document makes provisions for documenting the responsibilities for resource management on projects and includes resource management decisions from the design stage that can influence WM on site. It also documents progress of projects in relation to WM and serves as a basis for comparing different projects.

#### **8.6.2.7.3 Sustainability Report**

The company from time to time produces a sustainability report which serves as a means to showcase their WM performance. The sustainability report also showcases the progress of the company on environment and sustainability issues by measuring the performance as of the previous years and setting targets and commitments for the years ahead. This document also contains case studies that demonstrate the initiatives of the company towards sustainability in the construction industry.

#### **8.6.2.7.4 Register of Regulations**

To ensure the company is aware of all its legal obligations and complies with the demands of government legislation, the company has a register of regulations. This document helps the company to keep track of all legal requirements and summarises all the demands of every regulation that affects the activities of the company. As explained by the senior environmental advisor of the company, whenever there are changes or amendments to any regulation, this is made in the register of regulations to ensure the company is compliant. This makes the register of regulations an important aspect of WM within the company.

### 8.6.3 Strategies for WM at the corporate level in company C

Strategies for managing waste in Company C are discussed in this section under the themes of planning for WM; governance strategies adopted in the company; measures to outsource WM function; Monitoring of WM; Training and development; IT Systems to aid WM; and the documentation used in the process.

#### 8.6.3.1 Planning for waste management

The strategy in Company C for WM planning begins with the environmental managers for the respective regions who set the WM agenda. To ensure site teams sustainably manage waste, the environmental manager for any region ensures environmental and waste issues are well communicated to the site team through regular staff briefings, newsletters, and bulletins for urgent issues. The company uses the SmartWaste Plan produced by BRE as a framework for planning and managing waste on site. Majority of the decisions on WM is taken by the project manager or people the project manager may delegate for such purposes. Planning for WM on projects begin with knowing and estimating what wastes are expected and making sure targets are set for all identified waste streams.

#### 8.6.3.2 Governance strategies for waste management

In terms of governance, there is a well-defined structure for WM within the company as gathered from interviews with the Central environmental manager. The highest management position with responsibility for WM within the company is the group environmental manager who oversees the overall environmental duties within all four of the company's businesses streams. The environmental manager and team (environmental advisors) provide assistance to project managers who have the final say on the WM practices on their projects. Environmental managers are responsible for setting waste targets, aims and objectives for their area (business) on yearly basis (including all environmental targets) and also help during the preconstruction stage of the project by helping the preconstruction team to identify any environmental issues or waste issues especially with soils, excavated materials, remediation *'and pointing the preconstruction team in the right direction'* (Central Environmental Manager, Company C).

During the construction stage, the environmental managers assist project leaders. Support to project teams come by way of *'identifying environmental aspects, impacts, general*

*advice on waste and good site management practices*’ (Central Environmental Manager, Company C) during periodic visits to their projects. The governance strategy for WM is shown in figure 8.14.

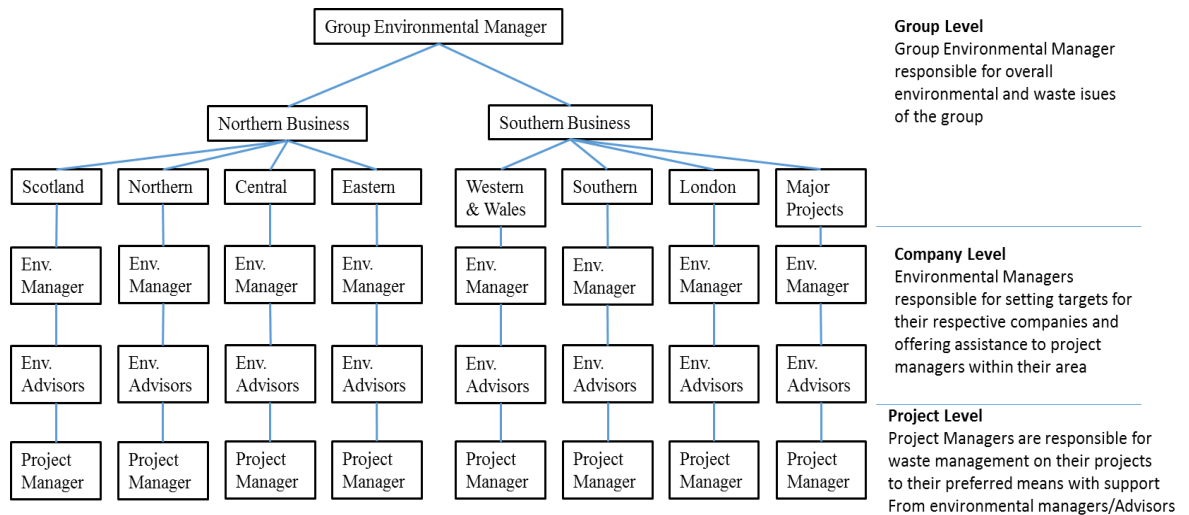


Figure 8. 14 Governance structure for WM Company C

### 8.6.3.3 Outsourcing for waste management

To ensure waste is sustainably managed within the company, outsourcing of certain activities relating to WM is done by the company. Outsourced aspects of WM include the provision of skips for WM and the transfer of waste.

### 8.6.3.4 Monitoring of waste management

As reported in the environmental policy of the company, the overall monitoring and improvement of activities is the responsibility of senior managers in the company. The policy states that, “*Senior management will review this policy annually and establish environmental objectives and targets that are consistent with the company's current policy commitments*” (Environmental Policy, Company C). Strategies to monitor the performance of WM on the projects of Company C are the responsibility of environmental managers who have the oversight responsibility of the activities of site teams.

### 8.6.3.5 Training and education on waste management

Environmental training is one of the KPIs of the company at group level according to the Central Environmental Manager as the company considers environmental performance as a major aspect of their activities. Training and education in company C is the responsibility

of environmental managers who point the site or projects teams *in the right direction* (Environmental Manager) concerning waste and environmental issues. Project leaders however have the responsibility to train their site teams and ensure they understand WM requirements. Sub-contractors are however in charge of training their site staff to ensure they meet the WM demands and requirements of the company.

#### **8.6.3.6 System for waste management**

The company has an integrated management system (IMS) which helps to capture waste data and aid site teams in keeping track of performance.

#### **8.6.3.7 Documentation for waste management**

For Company C, the documents that affect WM are: the environmental policy, the Smart Waste Plan (bespoke version of the site WM plan), the site WM plan for sub-contractors, and the sustainability reports. Brief summary of these documents are given below.

##### ***8.6.3.7.1 The environmental policy***

The environmental policy document of the company shows the company's commitment to environmental and WM issues and acknowledges the negative impact of their activities on the environment. The commitment to comply with legislation is the number one requirement of the environmental policy. The environmental policy of the company states the principles and strategies towards environmental and WM and these are to *"Promote, as far as is practicable, responsible sourcing and the purchase of materials and services that through their use, sourcing or manufacture have the least harmful effect on the environment."* The policy document also gives the responsibility to senior management to review and establish environmental objectives.

##### ***8.6.3.7.2 SmartWM Plan (Site WM Plan)***

To help with the planning and monitoring of WM on their projects, the company has a bespoke version of the site WM plan which was developed in association with the Building research establishment (BRE). This document helps to plan and record WM which is then transferred to an online portal (SmartWaste Plan) which helps to monitor the quantities of waste and the management options used.

#### **8.6.3.7.3 Site WM Plan for sub-contractors**

To ensure sub-contractors on their projects abide by the demands for WM requested by the company, there is a WM document for sub-contractors which lists a number of information required from them. The document requires sub-contractors to identify the waste types they are likely to produce and consider ways to reduce these waste types through design or on site practices. The document also requires sub-contractors to inform their workforce on the importance of WM and waste minimisation. The SWMP for sub-contractors is completed and submitted as part of contract documentation for the sub-contractors.

### **8.6.4 Strategies for WM at the corporate level of company D**

Strategies for WM in Company D are discussed below.

#### **8.6.4.1 Planning for WM**

The number one strategy for WM in company D is planning and this is due to the nature of the company. Goal setting for WM forms the basis for planning at the corporate level of the company. This is aided by the use of an environmental management system (EMS) which according to the environmental policy of the company *'forms a good platform for individuals to understand how they are expected to operate'* (Environmental Policy, Company D). The company's WM standard document *details the minimum standard for the management of waste resulting from activity on construction sites across all of Company D's (name withheld) construction projects*. At the time of data collection, the target for WM was 0% of waste to landfill by the end of 2014. For planning purposes, the company uses *"Site WM Plans (SWMP) on all projects over £300,000 and operate waste reports on all projects with a lesser value"* (Group Standard waste Dec 2013). At the time of data collection, the company was in the process of creating an app that could be used as the basis for planning and monitoring of WM on projects.

#### **8.6.4.2 Outsourcing**

Outsourcing of WM activities is a key strategy adopted by the company. Waste collection and transfer on all the projects of the company are outsourced to a WM contractor. According to the environmental manager, the WM company (contractor) ensures the company only deals with firms that are compliant with legislation, and takes care of all arrangements for provision of skips and waste transfer stations. According to the environmental manager, due to difficulty in sometimes capturing waste data, the company



has also invested in eDoc, which is an electronic means to capture waste data direct from their skip companies. This investment however had not started working (at the time of data collection) due to the arrangements the company has with their waste brokers. As the environmental manager explained, fully outsourcing waste handling and transfer activities helps the company to concentrate on other ‘important’ matters.

On some big contracts however, (as the environmental manager explains), the sub-contractors used may have their own means of WM. She made this comment in reference to Project D2 “... a big project like this, the demolition contractor will look after their own removals from site because they’ve probably got their own skips and vehicles to do it, it’s the most cost effective way.” Even in such instances the company still maintains the overall responsibility for managing waste.

#### **8.6.4.3 Waste management monitoring strategies**

Monitoring is very important strategy because the company mainly (only) manages the projects they are involved in. The company’s environmental manager summed up the monitoring strategy and its importance in the extract below: “We are, primarily, concerned with ensuring that the sub-contractors that we use, ...cos we’re a management contractor, we don’t have any training, so all the waste that the sub-contractors create, either they take it away and provide us with a carriers licence/destination licence, or there’s a range of skips and they’re sharing them and it depends on the nature of the project and what sort of work there is to do”. At the project level, the company has site managers in charge of waste who have the responsibility of monitoring activities. The EMS used by the company also helps in monitoring performance on WM as it forms the basis for analysing waste figures from project to project. The company keeps records of the waste data generated on projects to enable them compare performance between projects.

#### **8.6.4.4 Governance of waste management**

The company has a simple management structure in place to ensure the issue of WM is well taken care of at the highest level in the company. The highest level for decision making on WM is the construction director who serves as a board member of the company.



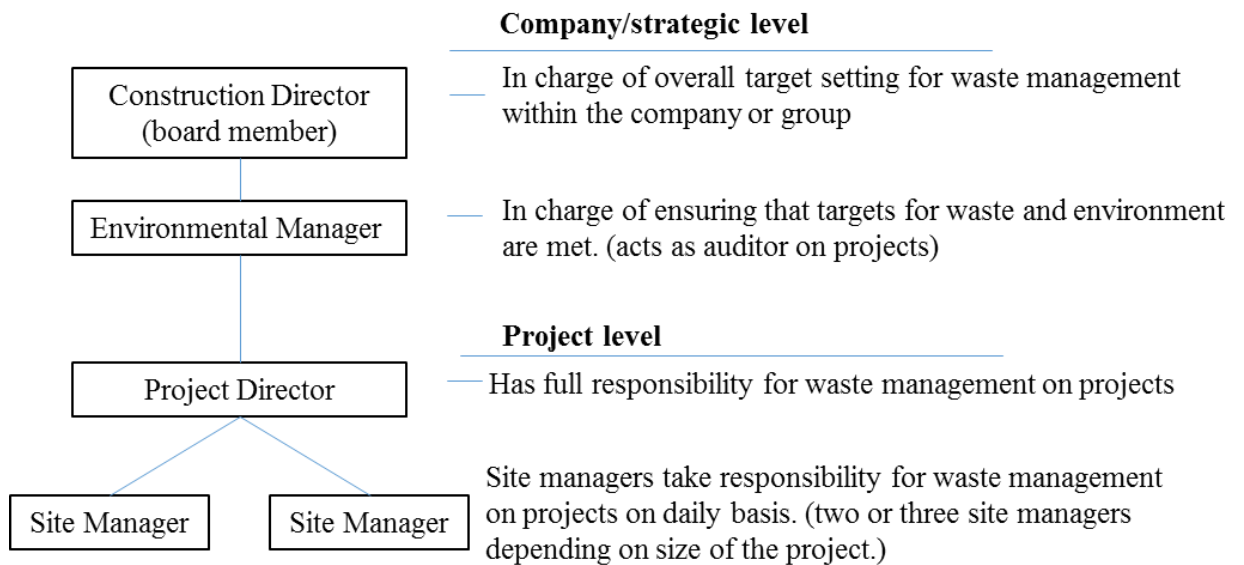


Figure 8. 15: Governance structure for waste management Company D

As described by the environmental manager, the construction director is very passionate about waste and takes charge of the overall goal setting of WM. Between the construction director and the project teams, there is an environmental manager who reports directly to the construction director and is responsible for auditing and monitoring of WM duties by project teams. She describes her role as “*an auditing role, make sure everybody works towards exceeding those targets*” (Environmental Manager, Company D). On projects, the environmental manager also assists project managers or directors (depending on the project) to meet the targets set in their tender documents. At the project level, there is a project director/manager on each project in charge of overall waste and environmental management duties. Depending on the size of the project, there may be two or three site managers who help the project manager.

#### 8.6.4.5 Training and Education

The strategy towards training and education on WM at the corporate level take the form of tool box talks designed by the company. These tool box talks form the basis for educating and training site teams on WM issues. Tool box talks on WM provide training on best practice in two main areas: best practice towards waste reduction; and best practice towards WM. Training on reduction targets means to prevent materials from ending up as waste whereas management targets the activities to ensure waste can be reused or recycled. At the project level, project directors and managers are in charge of WM training.

#### **8.6.4.6 Waste management systems**

Company D has an environmental management system which the company sees as a means to help them *minimize the impact of their activities on the environment* (Environmental Policy, Company D). This system forms “*a good platform for individuals to understand how they are expected to operate*” according to the environmental policy of the company. The system also forms the basis for recording WM information captured from their site WM plans. As a result of using the system, the company operates a portal based site WM plan instead of the paper template. The environmental manager explains this as follows: “*we had a template that we managed manually, but about four years ago, we moved to using a portal based system with a company called (name withheld) who acts as a waste broker. So, we gave them our paper based template and they developed the portal of a very similar look and feel*” This system serves as the basis for monitoring and deciding waste management targets based on data gathered from the projects.

#### **8.6.4.7 Documentation for waste management**

Company D has three main documents that help in setting and implementing WM strategies. These include the environmental policy; and the standard waste document. The company also uses tool box talk documents and site WM plans on sites. The environmental policy and standard waste documents are discussed below.

##### **8.6.4.7.1 The Environmental Policy**

The environmental policy of Company D states the company’s commitment to environment and WM issues. The policy promises the company’s commitment to continual improvement, pollution prevention and legal compliance. The two paged environmental policy document presents the company’s approach to waste and environmental management and this includes exceeding industry good practice on environmental and sustainability issues; ensuring staff have access to appropriate training and information; participate in environmental initiatives; offer customers alternatives; preference for the use of materials, products and services with reduced environmental, and social impacts.

##### **8.6.4.7.2 The standard waste document**

Aside the environmental policy document, Company D has a standard waste document which serves as a WM policy and specifically sets their commitments for WM and outlines the main areas that need attention. *The standard details the minimum standard for the*

*management of waste resulting from activity on construction sites across all (Company D's) construction projects* (Standard waste document). The policy shows the company's commitment to use site WM plans (SWMPS) on all project £300,000 and a waste report on projects with lesser values. The standard waste document also shows the company's support for the use of energy from waste as means to displace fossil fuel when all recycling options have been exhausted.

#### **8.6.4.7.3 Tool box talk document**

The tool box talk documents analysed as part of the WM document for the company is intended to help site teams to know areas that demand most attention in terms of WM. The tool box talk document makes reference to legislation and details the relevant legislation for WM on site. The document details best practice waste reduction and best practice WM for project teams.

## **8.7 COMMON TRENDS IN CORPORATE LEVEL WASTE MANAGEMENT**

From the corporate level of all four companies used for this research, a number of common trends were identified. In the area of WM vision, it was identified that all four companies had similar visions for waste management though the specific targets differed. For all four companies, the vision for WM was to ensure the negative influence of waste on the environment and their sustainability efforts is reduced while reducing the cost of waste to their business. For these reasons, efforts at the corporate level of all four companies focused on resource efficiency and reduction in the amount of waste sent to the landfill. As part of the visions for WM, the target for waste to be diverted from landfill ranged from 95% to 100% for all companies.

Similar drivers were identified to be responsible for WM at the corporate level of all four companies. Though the impact of the drivers varied, the main drivers for WM in all companies were: sustainability concerns; economic considerations; company image, environmental concerns, client demands, government legislation, benchmarking, moral and social imperatives, and the requirements of standards. In terms of approaches towards WM management, it was also identified that common approaches were adopted by the companies at the design, procurement and construction stages. These approaches include:

designing out waste through resource efficiency; supply chain arrangements for sub-contractor selection; responsible sourcing; reliance on senior management on their projects; partnering with sub-contractors; staff training; low waste technologies; and the use of site waste management plans (SWMPs).

The approaches to WM at the corporate level of all four companies resulted into similar strategies which covered planning, design, procurement, construction, demolition and disposal of waste. Planning in all four companies however differed from one to the other as different documents were used by all companies. A common document however was the SWMPs or Resource Management Plans (RMPs) which helped companies in forecasting waste and served as a means to measure performance. Companies also differed in terms of the governance systems in place at the corporate level for WM. Though government systems differed, the roles all centred on ensuring the best decisions are made in terms of waste prevention and management.

### **8.8 CHAPTER SUMMARY**

The results from corporate level WM suggest that WM is an important aspect of corporate activities in all the four companies. All companies have measures in place to ensure WM is given the needed consideration. As seen from the framework for corporate level WM, this begins with a vision for WM which is fuelled by a number of values. Values fuelling WM vision of companies stem from the beliefs that waste has negative effects on finance and on the environment, and WM can lead to improved environmental performance and economic returns. The approaches of the companies to manage waste generally concentrate on ensuring a reduction in the waste produced by targeting design options, procurement arrangements, and management on projects. These approaches to WM translate into operational strategies and involve strategies to: plan; outsource; monitor; train and educate project teams; as well as government structures; WM systems; and documents to aid WM efforts. The vision; approaches and strategies for waste management at the corporate level are intended to influence project teams to manage waste on construction projects. The next chapter presents results from the project level to determine how corporate level influences WM on project sites.

## CHAPTER NINE

### WASTE MANAGEMENT AT THE PROJECT LEVEL

#### 9.1 INTRODUCTION

The vision, approaches and strategies for WM determined at the corporate level of the companies influence the site teams to manage waste. In this chapter, the approaches and practices for WM at the project level of the companies is discussed. The chapter begins by discussing the ‘vision for WM’ (established or implied) at the project level, which forms the basis for all WM activities on projects. This is followed by the drivers that dictate WM and influence the approaches and strategies adopted on site. Beyond the drivers for WM, factors identified as enablers of WM which affect the success or otherwise of WM on projects are also presented. The chapter concludes with a review of common waste streams identified on the projects and the management practices applied to them.

#### 9.2 PROJECT LEVEL WASTE MANAGEMENT VISION

The vision for WM at the project level as defined in chapter seven covers the overall goals of the project teams regarding the management of waste on their projects. The visions for WM on all projects visited are presented below.

##### 9.2.1 Project level waste management vision - Projects A1 and A2

On both Company A’s projects A1 and A2, the visions for WM were to a large extent determined and directed by senior management on the projects. The visions are summarised in table 9.1.

Table 9. 1: Waste management vision on Projects A1 and A2

Project	Project A1	Project A2
<b>Waste Management Vision</b>	To ensure all waste is managed to meet the company sustainability agenda through sustainable resource use leading to waste reduction	To ensure sustainability remained number one on the project’s WM goals with emphasis on recycling

### 9.2.2 Project level waste management vision - Projects B1, B2 and B3

The vision for WM on all three projects differed to an extent though the overall vision was to ensure waste is diverted from landfill according to the company's corporate level vision. On project B1, the vision for WM was to a large extent determined by the project manager who according to the other site staff interviewed, was '*very passionate about waste*'.

Table 9. 2: Waste management vision on Projects B1, B2 and B3

Project	Project B1	Project B2	Project B3
<b>Waste Management Vision</b>	To manage materials to ensure little waste is generated and where possible, recycle materials	To ensure reduction in the amount of waste generated with emphasis on reducing cost of waste to the project	To ensure compliance with the company procedures.

From an interview with the project manager on Project B2, his main concern was to ensure the project finished on time, and within the budget and any strategies towards WM should focus on cost reduction by reducing the amount of waste generated. For this purpose, waste reuse was the most prominent WM option on project B2. In the words of the resource manager on project B3, the vision is "*...ensuring compliance against our procedures, ensuring we're doing all the bits that we say we do and all of the performance bits are done as they should be*'.

### 9.2.3 Project level waste management vision - Projects C1 and C2

The vision for WM on the two projects C1 and C2 differed based on the preference of the project teams put in place for each project.

Table 9. 3: Waste management vision on Projects C1 and C2

Project	Project C1	Project C2
<b>Waste Management Vision</b>	to ensure the site teams had a full understanding of the company and the client's requirement for WM, and to meet those requirements by following the Company's laid down procedures	To " <i>as much as possible minimize the amount of waste going off the site.</i> " (Project Manager, C2) and this required an increase in the reuse of waste generated on the project

The project manager for Project C1 explained the vision for WM on his project: *“as a senior project manager, I’ve got to make sure that, first of all, we understand what the requirements are for the project in terms of ...we’ll be given certain targets and a BREEAM - we’ll be given certain targets - and what we need to do to fulfil the client’s requirements.”* He continued *“...and then, secondly, we’ve got our own environmental policy particularly revolves around SMARTWaste that we comply with all the environmental requirements of our company.”*

#### 9.2.4 Project level waste management vision - Projects D1 and D2

Similar visions for WM were identified on projects D1 and D2 and there were jointly developed by the project managers and the company Environmental Manager who was present on both projects. On both projects, the vision was to ensure the site teams complied with the Company’s laid down procedure for WM, especially ensuring prevention of waste and the segregation of waste on site.

Table 9. 4: Waste management vision on Projects D1 and D2

Project	Project D1	Project D2
<b>Waste Management Vision</b>	To <i>“identify what the waste is likely to be and have a robust strategy for managing in terms of what you’re gonna do with it.”</i> (Project Manager, D1)	<i>“To ensure the site managers comply with our procedures especially segregating waste.”</i> (Project Director, D2)

From the result on waste management vision on projects, it was evident that: in projects from company A, B and C, WM vision at the project level within the same company differed from one project to the other and this is mainly due to the preference of project managers. For projects from Company D however, both projects had the same vision and this was largely due to the presence of the company environmental manager who developed the vision together with project managers or directors. This suggests that when left on their own, project teams may influence the vision for waste management which will then dictate the extent of waste management.



### 9.3 DRIVERS FOR WASTE MANAGEMENT AT THE PROJECT LEVEL

It was identified that similar drivers were responsible for waste management on all the nine projects though the extent of the drivers differed from one project to the other. For projects from the same company, it was also identified that the drivers for waste management and their extent differed slightly and this to a large extent was based on project characteristics. The extent of influence of drivers on WM at the project level was determined by the level of emphasis made to particular drivers by different people on the same projects. In some instances, participants were asked to rank the drivers influencing WM on their project. A summary of all drivers on waste management at the project level is given in the figure 9.1.

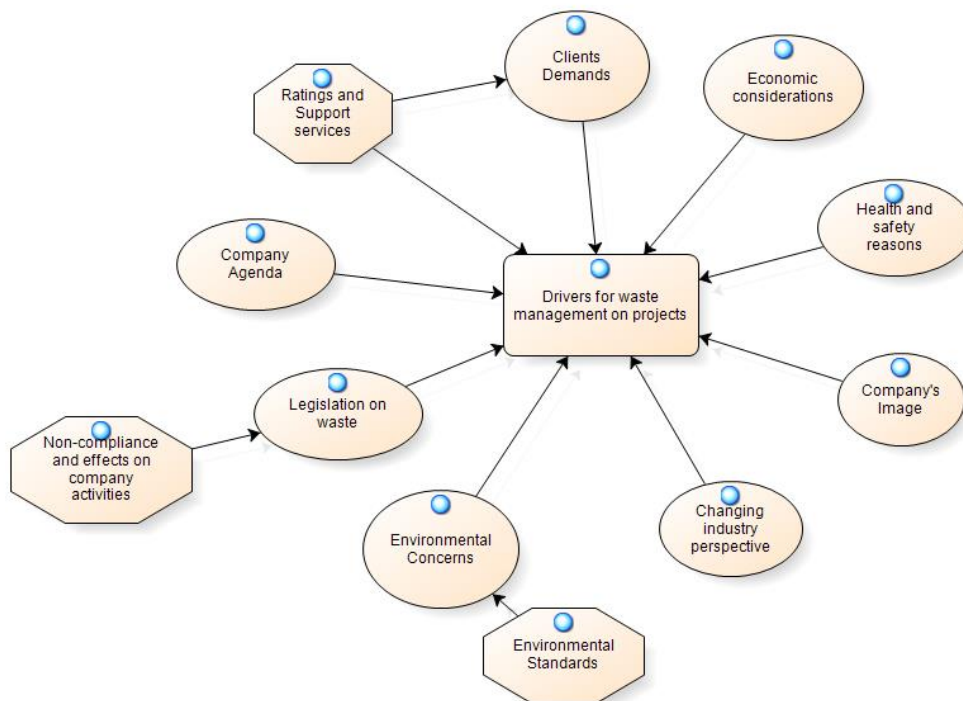


Figure 9. 1: Drivers for waste management on projects

From figure 9.1, it can be seen that the main drivers for waste management at the project level are: economic considerations; client demands; company WM agenda; changing industry perspective on waste; company image; concerns for the environment; government legislation; requirements of standards; and health and safety reasons.

Though the influences differed, economic considerations and client demands were identified to be the most influential drivers on projects towards WM. Cost was a very influential driver because site teams (who are involved with the execution of projects) have



keen interest in the cost implications of efforts on projects. In an interview with the Design Manager on Project B1, he suggested: *“cost as a driver is currently an industrial thing where ways of saving money is a key driver for many activities in the industry and waste management is definitely one of them. At the end of the day, everything comes back to cost. The cost of transporting waste out of site also drives practices where steel or timber when segregated can be taken away for free but mixing the waste means the need to pay for segregation.”* The Senior Site Manager on Project D1 made similar comments suggesting cost was very important to project teams: *“the incentive (for the site team) to put things in the right skip is also a cost incentive because if we put wood and metal together, then they charge us more money for the skip. So, we make sure that people use the right skip for the right product and then it reduces our costs.”* General comments from all 9 projects suggested that cost was the key driving force behind WM efforts. The Project Director on

It was also identified, the cost was the easiest message to ‘sell’ to operatives who were involved in handling materials and work processes and as such project managers made sure education of site teams on waste management focused on the cost implications of their actions.

The next most important driver for waste management on all nine projects was client demands where site teams were influenced by the specific demands a client may have for waste management. The extent of client demands driving waste management on projects was to a large extent determined by the type of client. The South East Environmental Manager for Company B who served as an Environmental Manager on Projects B2 and B3 had this to say concerning client demands as a driver for WM: *“the client has got the money and it depends upon what they feel. Some clients will go for the BREEAM rating, which is highly coded, highly energised to wastage and control thereof, whereas clients that don’t have would just be happy to get their building up and not consider that.”*

The client plays a major role in driving waste management. This was however based on the type of clients. As gathered from the interviews, some clients are only interested in getting their projects done on time, to specification and budget and do not have much interest in WM and as such do not drive waste management. It is clients who are interested in waste management who have demands driving WM. Company D for example has clients who are interested in putting up sustainability reports and as such will require high performance on waste management and these requirements drove WM on their projects.

Beyond economic considerations and client demands, there is a changing perspective in the industry on the environment and this to a large extent drives waste management. The general move towards being 'Green' serves as a driver for waste management. This is because being green has become the new trend to win contracts, especially for 'Green' conscious clients. According to the Electrical Engineer on Project C2, *"being green is the only way you get the work; you have to be green now"*. For this reason, there is the drive to sustainably manage waste, leading to reduced environmental impact which is an integral part of being green.

The changing industrial perspective is largely driven by concerns for the environment which in itself serves as a driver for waste management on projects. This was common to all projects as site teams had full knowledge of the current trends and the need to conform by managing waste sustainably.

The need to comply with legislative requirements was seen as one of the drivers of WM. Legislative requirements such as the need to transfer waste to qualified persons, the need to seek clearance for the management of special waste, the need to use WM plans (not legally required anymore), are factors that greatly impacted on site level WM strategies. Among the senior members of the site teams there was an agreement that legislation drives WM activities. The environmental advisor for projects B2 and B3 suggested that legislation serves as a driver for WM practices on site due to the setting of fines and penalties. In the words of the Environmental Advisor: *"Yeah, I guess it does because it makes us, an industry, we perform, yeah. I don't think it affects me on the ground as much, inasmuch as a policy comes out from the company 'you are to do this.' And that may be driven by current legislation"*. This point was iterated by a brick layer on Project B2 who felt legislation is rather a weak driver. He had this to say: *"I don't see any particular one getting arrested for doing the wrong thing on site. There's never anybody that seems to be held accountable, as such, for misuse of waste, unless of course it's down to oil leaks, or something that's very serious like that."*

Though legislation drives waste management on projects, it was seen not as the most influential driver as site teams felt there was not much in terms of prosecution for non-compliance with waste legislation. Site teams compared waste management legislation to health and safety legislation and suggested that waste management legislation did not have the level of impact health and safety legislation had.

Health and safety concerns were also identified to drive waste management on projects. This was especially so for projects where health and safety officers has roles to play concerning waste management. The Sustainability, Environment, and Community Manager on project A2 gave this comment regarding the role of health and safety: *“the main driver is not to create unnecessary waste because if you walk around the site and you see poorly stored materials, damaged materials, that’s also a health and safety risk as well, but when you walk around a site that’s well managed, materials are well stored, there isn’t a huge amount of waste, it’s a better project.”*

As seen from this section, drivers for waste management at the project level depend to a large extent on how much effort is put into ensuring corporate level drivers influence site teams. For project where corporate level staff influenced the process, drivers are more likely to align with corporate level drivers and project specific factors. Projects where health and safety professionals were involved, health and safety became a major factor and vice versa. In similar ways, in projects where corporate level staff monitored and auditioned waste management, concerns for the environment and company image became major drivers.

## **9.4 APPROACHES TO WASTE MANAGEMENT AT THE PROJECT LEVEL**

As mentioned earlier, the vision for WM at the project level translated into approaches which gave a general direction for how waste is managed on site. Approaches on the other hand determined the operational strategies (practices) towards WM. Approaches are discussed for all four companies based on the sections of the waste hierarchy and how they translated to operational strategies (practices)

### **9.4.1 Approaches to WM on Projects A1 and A2**

The approaches employed on the project sites to manage waste were largely dependent on site characteristics and the choice of senior management on Projects A1 and A2. Site teams were given the liberty to choose from the approaches determined at the corporate level based on project characteristics. A summary of the approaches towards WM on company A’s projects is presented in the figure below.

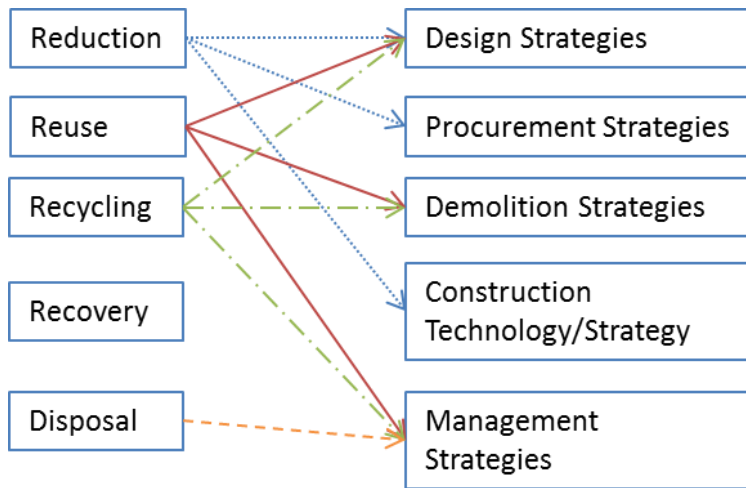


Figure 9. 2: Approaches towards WM at the project level - Company A

#### 9.4.1.1 Waste reduction

Waste reduction is tied to three main strategies: (i) design strategies; (ii) procurement strategies; and (iii) construction technologies. Design strategies involved measures and practices towards reducing the amount of waste generated on site through design options known to prevent waste generation. Procurement strategies are targeted at ensuring the procurement (purchasing) process results in materials that can help reduce waste generation. Construction technologies involve techniques used on site to prevent the generation of site waste.

#### 9.4.1.2 Waste reuse

This is tied to design, demolition and management strategies that encourage the reuse of existing materials which otherwise would end up as waste. Design approaches are strategies that help and encourage the reuse of existing materials. In terms of demolition, the approach involves the adoption of strategies that can maintain the integrity of demolished components or materials leading to increase in reusability of the materials. Management strategies focus on site level practices by operatives and workers who are in direct contact with materials or waste.

#### 9.4.1.3 Waste recycling

Recycling focuses on management and demolition strategies that encourage recycling of materials (waste) and the use of recycled materials. Demolition to encourage recycling

involves ensuring demolished materials are not mixed to encourage recycling. Management strategies involve the management of materials (waste) through proper handling and segregation to prevent contamination which encourages recycling. This also included design approaches that promote the use of recycled products in the design of projects.

#### 9.4.1.4 Waste recovery

No evidence of waste recovery was gathered from the projects used. The sustainability manager of the company suggested that recovery hardly pursued on their projects.

#### 9.4.1.5 Waste disposal

Here the emphasis was on ensuring disposal of waste follows legislative requirements. This approach relies on management strategies on site towards ensuring only non-reusable or recyclable waste is landfilled, and that waste is transferred only to companies which are legally compliant.

#### 9.4.1.6 Project level waste management practices - Company A

The approaches towards waste reduction, reuse, recycling, recovery and disposal all translate into operational strategies which determine the practices adopted to manage waste on projects. This section discusses the practices adopted to apply the strategies discussed above on projects A1 and A2.

A summary of the practices adopted on Projects A1 and A2 is provided in table 9.5.

Table 9. 5 Summary of waste management practices on projects A1 and A2

WM strategy at project level	Summary of waste management practices
<b>Design to reduce waste</b>	Design for reuse of existing materials, prefabrication, and the use of standardized sizes
<b>Planning for WM</b>	Forms the basis for management on site and begins at the tender stage with an idea of types and quantities of waste expected to make arrangements for management of waste

<b>Quantification of waste</b>	Forecasting the quantities of waste expected on the projects to allow planning consider what to do with them
<b>Outsourcing</b>	Outsource skip provision and waste handling and transfer to waste brokers
<b>Management of special waste</b>	The use of external specialist contractors to manage special waste (asbestos etc.).
<b>Deconstructing</b>	Taking apart existing structures to ensure valuable materials are kept for reuse
<b>Segregation</b>	Provision of different skips for different waste streams to encourage recycling
<b>Use of cutting sheds</b>	Sheds to ensure offcuts are kept and reused where possible (without mixing with other materials)
<b>Supplier take back schemes</b>	Making suppliers of materials take back packages and pallets to ensure manufacturers recycle at points of production
<b>Use of recycled materials/Recycling</b>	Recycling demolished or deconstructed materials for reuse on or off site.
<b>WM training</b>	Site briefings and tool box talks on good practice WM and through an e-pod system
<b>Monitoring of performance</b>	Use of the IMS for capturing project data and performance monitoring by senior management on site. (Checking and keeping of receipts and licenses).

#### ***9.4.1.6.1 Planning for WM***

Planning strategies for WM on Company A's projects begin at the tender stage of projects where a fair idea of the volumes of waste expected is used to identify opportunities for management. For brownfield sites and works involving demolitions, this is to help identify materials with reuse capabilities. For design and build projects however, this occurs at the design stage where planning considers efforts to reduce waste by design. Information generated is inputted into WM plans which form the basis for WM practices during the construction phase. Practices under this strategy include: initial site surveys at the

mobilization stage to determine site conditions; quantification of the volumes of waste expected; and the identification of opportunities for reuse of waste/material. On project A1, which involved demolition, a specialist firm was brought in to do destructive testing which according to the waste manager, *“helps to know what to expect on site”*.

Planning also helps the site team to set the contract order for waste handling companies based on the choice adopted. During the process, WM documents such as the waste minimisation and resource efficiency guidance, WM guidance notes, and the WM procedure document were used in the planning process.

Quantification was an integral part of the planning process. Quantification, according to the Waste Manager on Project A1 *“gives us (the site team) the opportunity to look at potential savings. If we find a situation where we have to, for instance, import a large amount of fill to fill a bit of land to get it level, if we can have the opportunity to utilise some of the materials that are coming in from the demolition phase, to cut that down, we can save on both sides. So, there’s the potential for us to look at programming the job in such a way to make use of the resources that we’ve got on the site.* The practice of quantifying waste has an impact on the overall planning/management of the project as it influences the programming of the activities on site.

#### **9.4.1.6.2 Management structure for WM on project**

To achieve the goals of WM, a structure for WM is instituted at the project/site level. As part of the company’s strategies, senior management are in charge of WM on projects. On project A1, a senior engineer as part of the site team acted as the waste champion (waste manager) on site and was responsible for overseeing all WM activities or practices on the project. His responsibilities included ensuring the collection and keeping of waste licences, receipts and records to meet legislative demands, and managing the logistics company in charge of providing skips for waste segregation and transfer of waste. The general structure for WM on project A1 is shown in figure 9.3 below.

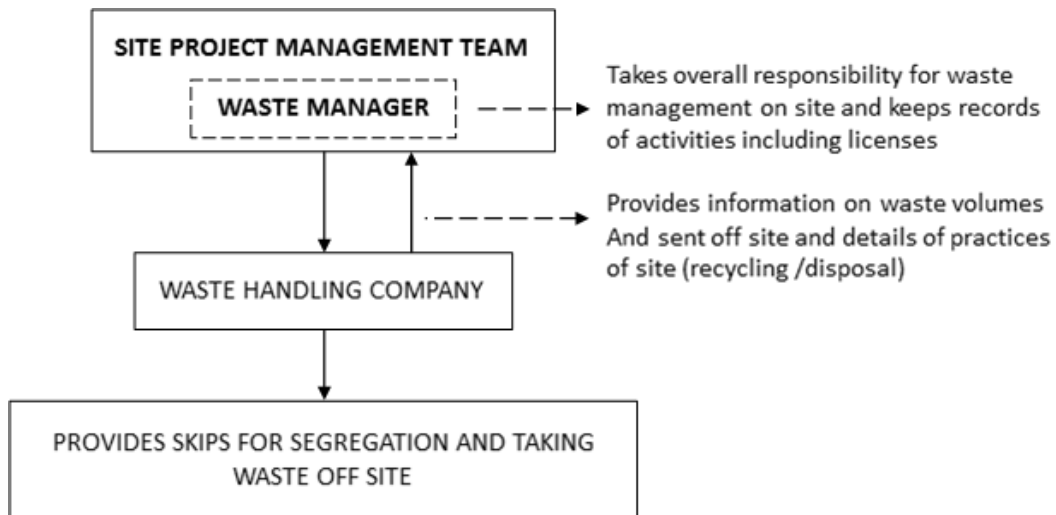


Figure 9. 3: Waste management structure on project A1

Unlike project A1, on project A2, there was no single person in charge of WM as many senior managers were involved with WM. There was however a sustainability, environment, and community manager who was “*the most likely person to have the most visibility of waste*” according to him. Due to the stage of the project at the time of visit (mainly substructure) on Project A2, the ground works logistics sub-contractor had responsibility for managing waste from that stage of the project.

#### 9.4.1.6.3 Outsourcing of WM responsibilities

As part of the site WM strategy, some duties outsourced were the management of special waste, provision of skips, transportation, transfer of waste, and in some cases management of waste on site. On project A1, WM responsibilities outsourced were the provision of waste skips, management of special waste and the transfer of waste off site. A waste logistics and handling company was contracted who provided different skips for the purposes of on-site segregation, took charge of waste transfer and provided the waste manager with details as required. On Project A1, skips were provided for: biodegradable waste; light iron and steel; timber; and mixed construction waste. A section of the skips are shown in the pictures below.





Figure 9. 4: A selection of skips provided for segregating waste on site – Project A1

On project A2, as at the time of visits, there were no outsourced WM activities. The assistant site manager suggested however, that there were arrangements to outsource some activities as the project progressed and more waste streams were identified.

#### ***9.4.1.6.4 Waste reduction by design***

Another strategy towards WM on projects is the strategy to reduce waste by design. This strategy encompasses practices such as: design for the reuse of existing materials, especially in the case of projects involving demolition; design to incorporate off site manufacture; and the use of standardized sizes. This strategy applies only when the company is involved at the design stage of projects. Though the interviewees from project A1 were not involved at the design stage of the project, they were of the view that design has a high impact on the amount of waste generated and managed on site.

The design manager on project A2 suggested prefabrication and modular construction happened to be some of the practices employed at company level towards WM.

On project A1, a number of components were prefabricated which required little or less ‘wet works’ on site. As observed during site visits, rings for making man holes had been prefabricated with in-built channels. This practice according to the assistant site manager was novel and would go a long way towards waste reduction.



Figure 9. 5: prefabricated rings for construction of manholes with channels already fixed

#### 9.4.1.6.5 Segregation of materials (waste)

On project A1, different skips provided for segregation of waste included skips for: light iron and steel; timber; and mixed construction waste. According to the assistant Site Manager for the groundwork sub-contractor, the main contractor provides skips for them (sub-contractors) and all they have to do is to ensure they put their waste in the correct skip. The provision of skips for segregation, according to him, helped reduce the time required for managing waste. On both projects A1 and A2, pallets were placed in a designated area away from all waste to help suppliers take back their pallets whenever new materials were delivered to the site. This practice, referred to as *supplier take back schemes*, helped to reduce the amount of waste occurring on site, and at the same time encouraged reuse and recycling of pallets.



Figure 9. 6: Pallets stored separately to encourage supplier take back - Project A1

Office and canteen waste were also segregated into different boxes as part of efforts to prevent the contamination of different waste streams and to ensure proper management/disposal of biodegradable waste.

#### ***9.4.1.6.6 Use of cutting sheds to prevent waste generation***

Another practice for waste reduction and reuse on A1 was the use of cutting sheds by sub-contractors. On project A1, the cladding sub-contractor had a cutting shed within the newly constructed building where cutting was done. This ensured offcuts from the cladding material remained segregated, and could be reused as and when needed. The cladding sub-contractor had this to say about the practice: *“we always save off-cuts, that’s our cutting shed over there, everything’s cut in there and we store all the waste like wood and if there’s a specific reason we need to use something, we will return there and say ‘oh, that piece is big enough, we’ll bring that out again.’ ”*. Cladding Sub-Contractors – Project A1

This practice helps to even transfer ‘waste’ to other sites where there may be need for such offcuts.

#### ***9.4.1.6.7 Deconstructing***

For projects involving demolition, practices adopted included: deconstruct where possible; or selective demolition. Through this process, materials deemed fit for use on the project site were deconstructed (a reverse of the construction process) to maintain their integrity and ensure reusability. Common materials in this case were bricks, timber and some steel.



Figure 9. 7: Deconstructing bricks from existing structure reused as retaining wall - Project A1

#### ***9.4.1.6.8 Responsible purchasing***

Responsible purchasing is another practice adopted on company A’s projects to ensure the right qualities and quantities of materials are purchased and delivered to project sites. This

practice is adopted to prevent over ordering which leads to excess materials ending up as waste on site. In cases where any materials have been over ordered, another practice adopted was to ensure any extra materials from the project is kept and carried to the next project, especially when similar projects are available or anticipated.

#### ***9.4.1.6.9 Use of recycled materials***

Another strategy towards waste reduction, reuse and recycling is to encourage the use of recycled materials. On the two projects, recycled materials were used as a means to not only reduce cost but prevent waste from being sent to landfill. The use of recycled materials however is influenced to a large degree by design specification. On project A1, majority of the concrete from the demolished slab was recycled and used as sub-base in place of new materials.



Figure 9. 8: Recycled materials from the demolition existing structure reused on site as hard-core - Project A1

#### ***9.4.1.6.10 Supplier take back schemes***

As mentioned earlier, *supplier take back scheme* is another management practice adopted on project sites where suppliers of materials take back packaging for their materials to ensure they do not end up on the construction site as waste. The design manager on project A2 suggested that suppliers taking back their packaging and pallets help to encourage reuse of materials instead of ending up as waste on construction sites which has to be dealt with by site team.

#### ***9.4.1.6.11 Waste management training and education***

Training for WM on sites is handled by the sustainability department and takes the form of site briefings and tool box talks. Company A has an e-pod (distance) learning system



(internal system) where various modules can be accessed by site staff. According to site staff interviewed, some of the modules focus on the management of waste on the project site. On project A2, training and education on waste took the form of site induction where all personnel including sub-contractor personnel are taken through training on health and safety and good practice WM. The WM guidance documents and the WM procedure documents all form part of the training materials for WM on the site.

#### ***9.4.1.6.12 Management of Special/Hazardous waste***

The practice of managing special waste, especially hazardous waste, in company A is to rely on specialist external personnel. Registering the site allows the site to operate with special waste and ensures all activities are done in accordance with the Hazardous Waste Legislation. On project A1, a specialist surveyor was brought in to do several asbestos surveys (visual surveys) to determine the presence of asbestos before possession of site. Based on this, the site was registered as a hazardous site. The specialist company then removed the asbestos from the site and issued a clean air certificate before demolition began.

#### ***9.4.1.6.13 Monitoring of waste management***

Senior management on projects maintain the responsibility to monitor WM performance on company A's projects. The company's integrated management system (IMS) served as a system for capturing all data on projects; to aid performance monitoring by senior management on site. The waste managers ensured all waste handling and transfers were done by the correct processes and the proper documentation used. Monitoring of activities also involved: the checking and keeping of receipts for the transfer of waste and copies of licenses of sub-contractors on the project (demolition contractors; asbestos removers; and waste handlers tip licenses). The sub-contractors on projects provided the company with notes and licences for their activities which the site team checked and uploaded to the IMS, particularly waste taken off the site.

On project A1, the sub-contractor in charge of providing skips for segregation had the responsibility to report waste volumes to the site team.

### **9.4.2 Approaches to WM on Projects B1, B2 and B3.**

Similar approaches to WM were adopted on all three of Company B's projects. The differences in the extent to which approaches are adopted were however dependent on

project features such as the type of project, the type of client, the stage at which the company was involved and the choice of the project manager or leader. A summary of the approaches towards WM on company B's projects is presented in figure 9.9.

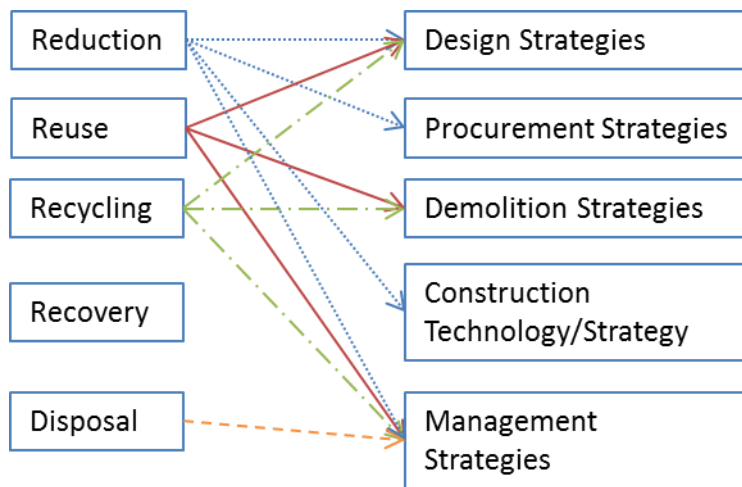


Figure 9. 9: Approaches towards WM at the project level - Company B

#### 9.4.2.1 Waste reduction

Approaches towards waste reduction can be grouped into four main areas: Low waste construction technologies; procurement arrangements; materials management options and design (when the company is involved at the design stage of the project). Almost all members of the project teams interviewed agreed that the first source to reduce waste was through design and for this reason the company ensured that reduction by design was pursued. In terms of procurement, the company approaches waste reduction by ensuring materials and companies that have a good record of reducing waste are allowed on their projects. Material management techniques targeted “*getting things right at the first time*” (project Manager, B1).

#### 9.4.2.2 Waste reuse

To ensure waste generated on projects are reused, the approach concentrated on design, management, demolition, and procurement. These approaches are targeted at ensuring waste generated on projects do not end up in the landfill by making good use of the value in the waste. Design approaches focus on specifying reuse of materials especially where there are existing materials such as demolished materials on site. The design process also ensures that reusable materials are specified, therefore design management is important.

The approaches to waste reuse by procurement entails ensuring reusable materials are purchased. Demolition approaches included ensuring the integrity of materials is kept for reuse through deconstruction and selective demolition. For project teams, key area of ‘*waste reuse*’ was sustainable management of materials on site to ensure off-cuts or materials with reusable values are reused.

#### 9.4.2.3 Waste recycling

Company B’s project teams placed much emphasis on recycling as an integral aspect of WM. Project teams approach recycling mainly by managing materials and ensuring separate collection of materials (waste) is done to enhance or promote the recycling process. Another approach towards recycling is through demolition strategies where materials with reusable values are kept for recycling. Approaches towards recycling also consider the use of recycled/recyclable materials during the project execution process.

#### 9.4.2.4 Waste recovery

Though little emphasis was put on recovery, approaches towards waste recovery take the form of planning and material management to ensure waste can be sent to recovery stations when available.

#### 9.4.2.5 Waste disposal

The ultimate vision on all projects of the company as stated in section 9.2.2 is to ensure the volumes of waste going to the landfill is reduced. Approaches towards sustainable disposal resulted to the use of sub-contractors who will help the company to collect and dispose of waste to authorised disposal facilities.

#### 9.4.2.6 Waste Management Practices on Projects B1, B2 and B3

The practices adopted to manage waste on Company B’s projects based on the approaches are discussed in this section. A summary of the practices is given in table 9.

Table 9. 6: Waste management practices - Company B

Waste Management strategy at project level	Summary of strategy
<b>Design to reduce waste</b>	Adopting design forms and shapes that lead to low waste generation on sites, Design for prefabrication and offsite manufacturing to prevent waste generation.

<b>Management structure (Governance)</b>	Senior management on sites have responsibility for WM with a nominated resource manager to oversee activities with duties such as checking for compliance. An environmental advisor serves as a resource person for site teams concerning environmental, health and safety, and WM issues.
<b>Planning for WM</b>	Planning for WM begins as soon as a contract is won and considered the most important aspect of WM. This forms part of the environmental management plan for projects where a checklist is used to identify restraints as well as opportunities for meeting targets for the project.
<b>Quantification of waste</b>	This forms an integral part of WM planning and a specific percentage for waste expected on the project is given based on the type of material under consideration
<b>Outsourcing</b>	Management of special waste, the provision of skips and the transfer of waste from project sites are outsourced by the company. One of two practices is adopted on projects: having a logistics company in charge of all waste; and managing waste by Company B and outsourcing waste transfer.
<b>Material handling processes</b>	Efforts were made to ensure materials were handled to prevent waste generation from damage
<b>Deconstructing</b>	A careful process to salvage materials for reuse during demolition by maintaining the integrity of materials.
<b>Reuse of waste</b>	Conscious effort to identify avenues for reuse of materials which could end up as waste
<b>Segregation</b>	
<b>Use of charging scheme</b>	To ensure compliance with company WM policies, a charging scheme was instituted where non-complying sub-contractors were charged especially for putting waste in the wrong skip.
<b>Supplier take back schemes</b>	Making suppliers of materials take back packages and pallets to ensure manufacturers recycle at points of production
<b>Management of special waste</b>	The use of external specialist contractors to manage special waste (asbestos etc.).
<b>WM training</b>	Site briefings and tool box talks on good practice WM, site inductions for sub-contractors and the use of notices and poster campaigns.
<b>Monitoring of performance</b>	Monitoring performance of site teams by project leaders and environmental advisors to help identify performance issues and deal with them accordingly. This was done through the production of performance reports by environmental advisors.



#### 9.4.2.6.1 Planning

Planning for WM on the company's projects begins as soon as the contract is won. Planning for WM is considered one of the most important strategies to ensure the site team achieve their vision for WM. According to the Project Manager on B1, WM is one of the first packages to be considered post contract award. In his words *"As soon as you've been awarded the contract, it's probably one of the first packages that you place, after accommodation 'cos the minute you've got accommodation, you're producing waste anyway from cabins, so you need a mechanism for getting rid of that."* The practices begin with getting the waste carrier on board. As the project manager for Project B2 revealed, *"if we spend a lot more time planning and getting things done properly from the start, we'd build a lot quicker, we'd built a lot more efficiently and we'd have then reduce the waste."* All personnel interviewed on projects B1, B2 and B3 were of the view that planning for WM is the most important aspect of all strategies. Majority of these people however believed that planning for WM should begin at the design stage of the project where there is greater opportunity for effective WM decisions.

At the project level, WM planning forms part of the environmental management plan. The senior site manager who doubled as the resource manager on project B3 summarised the planning strategy in the following extract, *"before commencement, we'd go through various checklists, identifying what the restraints are on a project, what the targets are going to be and what opportunities there are."* This strategy appeared to be the basis for planning on all three projects with the production of a resource management plan which formed the basis for planning.

As part of the planning strategy, project teams quantify the amounts of waste expected which is then input into the plan for managing waste on site. Quantification of waste forms an integral aspect of the waste planning strategy on sites. Different methods are used for quantifying waste to be generated on site. On project B2, the site manager for the bricklaying sub-contractor explained they quantify their waste by giving a general percentage based on the type of material used. In his words *"at the start of the job, we have a look at what type the bricks are and we make a decision on how much waste there would be. For instance, this job, since these bricks are a little bit temperamental and they're very brittle, I think we went from these ones, the usual two per cent waste, to five per cent and that is only because of the type of brick."*

#### **9.4.2.6.2 Deconstruction**

To ensure the reuse value of materials is maintained, a strategy towards demolition known as deconstruction is used. This strategy is used to ensure materials maintained their structural integrity when they come out of the existing structures. Due to this strategy, existing materials could be reused on given to the community for reuse.

#### **9.4.2.6.3 Crushing of demolition materials for reuse on site**

A common strategy for the reuse of demolition materials was the on-site crushing of demolished materials for reuse. This was mainly identified on project B1 where crushing of the existing building on site served as a source of materials for reuse.

#### **9.4.2.6.4 Management structure on projects**

The management structure for waste at the project level in company B was identified to differ slightly based on the project characteristics, the general or overall picture was that senior management on the project was in charge of the overall WM responsibility with help from the environmental advisors of the company. The project manager has the overall responsibility for WM but has a nominated person in who specifically oversees WM on the project. The duty of the person in charge of WM is to check for compliance with legislation such as licences for waste carriers and sub-contractors. The company's environmental advisors for the various regions offer assistance to the site teams by during visits to sites to *check that everything is in place* (Health and safety advisor, Project B3).

#### **9.4.2.6.5 Outsourcing**

The strategy to outsource WM at the project level is the preference of the project management team. WM activities outsourced at the project level include the management of special waste, and the provision of skips and transfer of WM. According to the site manager on project B3, *“Usually Company B directly deals with skips, waste, rubbish, collection of rubbish, putting in skips. Here, a logistics company is doing it, so we still have to pay for it, but it's just subtle, so we don't decide who the skip company is.* (Site Manager, Project B3). The Resource Manager on B3 also suggested the outsourcing of WM to a logistics company was a new thing to him *“This is the first project I'm using a logistics company, so that's been very much down to us in the past. However, there are certain processes with the logistics company, but they are using a waste carrier, the actual*

*logistics company aren't the carrier and we are then auditing that the licences are in place, the codes and everything like that."*

#### **9.4.2.6.6 Monitoring of activities**

The strategy to monitor WM on the three projects (B1, B2 and B3) were all concerned with ensuring that the site team follow the company's *"procedures on recording of waste and making sure it goes to the correct area with the correct waste licence."* (Project Manager B1). The practices for monitoring WM on projects was simplified by the resource manager on project B3 as follows *"We generate our targets, get an idea, put the controls in place - using the site waste, or the project resource plan - and then we will monitor, using the company's smart management system, so the information is generated at that stage and then monitored through the company's smart management system)."*

Waste monitoring practices also helped the site team to be able to identify any issues with the management on waste on site. As part of the strategy, in some instances, the site team may trail waste trucks to ensure they get to the correct station and also the waste goes through the correct process.

#### **9.4.2.6.7 End of project performance review**

The ability to review performance at the end of the project helps site teams to learn lessons from the project and carry it on to other projects. On project B2, it was identified that there will be a closing out review to cross check performance. As the health and safety advisor for the project suggested, *"There is a review at the end of the project, where we take the original estimates to the actual and compare the difference and a report is issued to the client as well, it's made available."* The resource manager on Project B3 suggested that the audit or review at the end of the project was rather a generalised audit and not specific to environmental audit. He suggested he had never been involved with any such closing out review session.

#### **9.4.2.6.8 The use of a charging scheme for sub-contractors**

A strategy to ensure waste is sustainably managed on projects is the use of a charging scheme for sub-contractors on site. On project B1 the practice was to charge site teams for putting waste in the wrong skips. In an interview with one of the labourers on project B1 who had to responsibility to manage waste, he suggested *"If they put the wrong waste in the wrong skips, maybe me, or another labourer will put it back in the right skip."*

*Obviously, take a photo first, to find out who's done it and they'll get charged to stop them doing it again."* When asked if this practice had made an impact on the rate at which people mix up waste he said *"it could be better. There're a few people that still are leaving a lot of waste and we're having to clear it up and take photos, but it has improved. Yeah, it's slowed down, since they have been charging and taking photos, it's slowed down a lot."* (Labourer, B1).

#### **9.4.2.6.9 Reuse of materials**

The strategy to reuse materials on projects begins with identifying use for materials which would otherwise have ended up as waste. This also involves purchasing materials with reuse value. On project B2, to ensure bricks were reused on the project, the site manager for the brick laying sub-contractor suggested *"We do, yeah, and how we do that is that every brick that we don't use, we put back on a pallet, we wrap it in Cling film and we put it over the yard and then, if we're coming to an area where the face work starts below ground, we bring all the left pallet and put it in the ground, so we'll have an idea how much is there."*

#### **9.4.2.6.10 Material handling strategies**

Another factor influencing WM on the project is the proper handling of materials. Being able to properly handle materials on site has the ability to reduce the amount of waste generated. According to a site manager on the project B3 considering the way materials had been handled on the project, he was positive the performance of the project in terms of WM would be very good. When asked his view on the performance of the project on waste he said: *"I hope so, there's no reason it shouldn't be, as long as they're realistic targets, which they are. So far, so good, we having been producing ... I don't think, anymore waste than we should be. I don't think it's a wasteful site, it's quite clean, we're not damaging lots of materials, it shouldn't really change, I think we should hit our targets, I don't see a reason why we shouldn't"*

#### **9.4.2.6.11 Training and education**

The strategy to train and educate people on WM issues on site concentrated on ensuring the site teams know their requirements and carry them out. On all three projects, education was regarded as an important aspect of WM and this mainly took the form of toolbox talks, site induction and the use of notices and campaigns on site. On projects B2 and B3, the

south east environmental manager described the strategy towards training and education in the following extract: *“We require one tool box talk, per sub-contractor, per month and then the three weeks left are health and safety. So, the one environment, and I think we give them a fair share of education, awareness, etc. We run campaigns, we have an environmental noticeboard. In the canteen, where they sit and eat, and I do an inspection, I give them a case study and I give them a tool box talk as an aide memoire for them to use those two in that month and I give that every month. I give them a new tool box talk and a new case study. So, I do feel that by education, by visual displays, I think the message is getting in.”*

#### **9.4.2.6.12 Standardization**

The use of standardized materials served as a strategy to reduce the amount of waste generated on site. This is either a designer led specification of standardized materials or project team led use of standardized sizes. On Project B1, *“when we’re doing the paving here, we’re trying to make the paving fit a full slab. Instead of say four metres, when cutting a slab, you might as well use a full slab. So, we’re trying to minimise waste on time, money and materials.* In talking about the need to standardize components to have a positive influence on WM, one Site Manager on B3 suggested this should begin from the manufacturers and designers.

#### **9.4.2.6.13 Prefabrication**

The use of prefabrication (off-site manufacture of components) served as a strategy for WM due to its influence on the levels of waste generation on project sites. As gathered from the interviews, site teams chose the options of prefabrication as a means to help get work done quicker on site while leading to little or no waste. On project B1, the Design Manager suggested that they had produced precast planks and this had contributed to less waste generation on the project. As the Design Manager Explained, *“you’ve got to make sure that your product is made in a factory, so your waste on site is minimised and it’s kept there, standardised units. If you buy the right lengths, which obviously again you can pre-cut off site, so you’re not getting site waste, so you’ve got less activity on site, you create less waste.”* Off-site manufacture was identified as a common practice on all of Company B’s projects.

#### 9.4.2.6.14 Supplier take back and buy back schemes

Supplier take back-schemes were adopted for certain materials (especially plaster boards). The South East Environmental Manager for the company shared the belief that supplier take back scheme is one of the best practices to reduce waste though very difficult to implement. *“I’m also a firm believer of contractors, or suppliers taking back their waste, but sometimes it’s rather difficult to push for that.”* The supplier is regarded as a very important part of the waste management/reduction process and must be included as part of the planning process.

The design manager on Project B1 informed of an arrangement with the suppliers of plaster boarding to buy back their waste. There was a variant of the take back scheme where some suppliers actually bought back the waste from the site for According to the project manager on B1 *“We send packaging back, waste back to British Gypsum, they have a buy-back system - so do Kingspan - with any insulation materials ‘cos it gets shredded and they*

### 9.4.3 Approaches to WM on Projects C1 and C2.

A summary of the approaches adopted to manage waste on Company C’s projects is shown in the figure below.

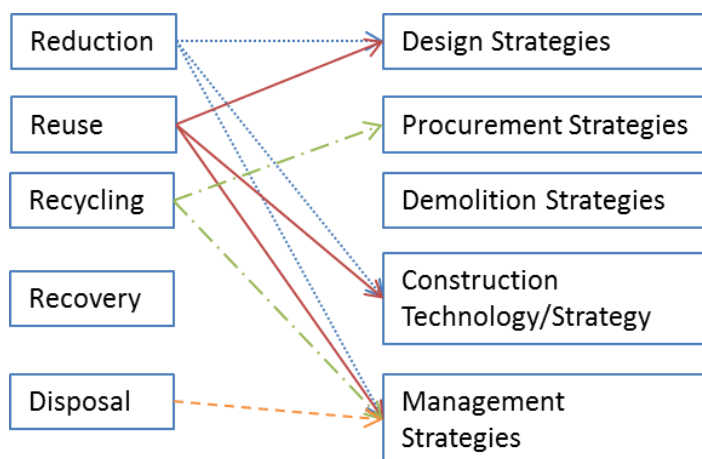


Figure 9. 10: Approaches towards WM at the project level - Company C

#### 9.4.3.1 Waste reduction

Similar approaches were adopted for waste reduction on both projects and these focused on: management; design (specification); design review; construction technology or procedure; and material packaging or handling techniques. On project C1, the project team put most emphasis on preventing waste from occurring in the first place. The approach to reduce waste through design was made possible as the project was design and build. On C2, similar approaches were directed at waste reduction.

The Project Manager for C1 explained the approach to waste reduction on project C1 in the extract below. *“As it’s a D&B project, we’re responsible for working with the designers. How can we make sure that we meet the target in the programme and the waste streams that we’re gonna be producing? when I sit down and I got through it in terms of materials - are we sure, that during the design, we select the low waste materials”*. The project Manager for C2 suggested that when it comes to WM, *“the first you think of is what you makes of soil levels, how you can to use soil on site.”* For this reason, design to reduce the amount of waste to go off the site by the use of cut and fills was adopted. For the purposes of waste reduction, project leaders do coordination checks to determine how waste reduction can be achieved from the drawings.

#### 9.4.3.2 Waste reuse

The approaches towards waste reuse on the projects also took the form of management, construction technology, specification, and works program. On both projects, initiatives of project managers such as design review also contributed to waste reuse on the projects. The type of construction technology adopted and specification were also identified as approaches adopted by the site teams to ensure waste generated on projects were reused. On project C2, a key approach towards waste reuse was the use of cut and fill to make formation levels. This according to the project manager helped to ensure excavated material was not taken off site but was reused to fill up certain aspects of the formation level. Aside excavated material, as suggested by the Project manager, there was not much opportunity to reuse other materials on project C2.

#### 9.4.3.3 Waste Recycling

Approaches towards recycling concentrated on ensuring segregation of materials on site which was mainly a management and handling strategy. This required waste to be sorted



on site into designated skips. On project C1 however, there were no skips for segregation as at the time of data collection. The project manager suggested this was as a result of lack of space on site for skips and as such a waste sub-contractor was given responsibility to segregate the waste off-site. On project C2, skips were provided to ensure waste was put into the correct skip. In an interview with the electrical supervisor on project C2, he suggested that some wastes such as offcuts of metals and trunkings are not avoidable and the approach towards such waste is to put them in designated skips so they are taken off site. The role of the sub-contractors regarding waste on this project was identified to end once waste had been put into the correct skips.

#### 9.4.3.4 Recovery

From the two case studies visited, waste recovery (through incineration) for the production of energy which is the fourth R of the waste hierarchy was not a target at the project level. None of the projects targeted this approach to WM and as such site teams involved could not provide information on the approach to waste recovery.

#### 9.4.3.5 Disposal

Approaches towards the disposal of waste took a managerial form as the company employed the services of a waste transferor or management company to ensure the sustainable disposal of waste from their site. The site team however kept an eye on the destination of the waste leaving their sites by ensuring registered waste brokers were used and also ticket or receipts were inspected to ensure waste had been taken to the right transfer stations or landfills.

#### 9.4.3.6 Waste Management Practices on Projects C1 and C2

The approaches and strategies for WM translated into waste management practices during the day to day running of sites. A summary of the WM practices on Projects C1 and C2 is shown in table 9.7.

Table 9. 7 Waste Management practices on projects C1 and C2

WM strategy at project level	Summary of Practices
Design to reduce waste	Design practices target ensuring site teams meet the cost plan for the project by minimisation waste generation (through specifying standardized materials or



components and the use of low waste technologies).

<b>Planning for WM</b>	Project level planning begins with review of designs to determine avenues for waste reduction such as how to deal with mass haul. Planning is mainly about logistics management on site.
<b>Quantification of waste</b>	Integral aspect of planning. The practice of the company is to put percentages of waste based on project characteristics and information from the environmental manager (advisor).
<b>Management structure (Governance)</b>	A number of people on projects have responsibilities for the purposes of WM on sites. At the beginning of projects, the project manager is in charge of ensuring a waste carrier is employed and also sets project WM targets. Administrative personnel is in charge of updating smart waste plan based on data from waste carriers, a gateman is in charge of ensuring all carriers have the required licences and checks to ensure waste quantities reported are correct.
<b>Outsourcing</b>	
<b>Reuse of materials</b>	Practice begins with identifying reuse potential of materials and includes putting materials with good value to other us
<b>Segregation</b>	Provision of different skips to ensure waste is segregated on site. (segregation was however not done on project C1 due to lack of space for providing different skips
<b>Management of special waste</b>	All sites are registered as hazardous sites to ensure compliance with legislation. Specialist sub-contractors are used for managing special waste such as asbestos.
<b>Storage and handling practices</b>	Strategies to properly store or handle materials adopted on site to prevent damage to materials delivered on sites.(e.g. storing bricks on pallets)
<b>WM training</b>	Training and education involved onsite training for all site staff and was done either by project manager and included tool box talks, site inductions and the use of signage on site, tool box talks, and
<b>Monitoring of performance</b>	An online portal is used for monitoring WM performance on site. Monitoring is the responsibility of a number of people on site and includes checking the licenses of sub-contractors. Environmental advisors have oversight responsibility.

#### ***9.4.3.6.1 Design to reduce waste***

On projects where Company C has influence on the design stage, the strategy targets ensuring the project meets their requirements for WM. Project C1 was a design and build project and this allowed the application of the strategy. The project manager for C1

explained how this occurred: *“As it’s a D&B project, we’re responsible for working with the designers. The reality is there is a cost plan, there is a finite budget and there’s a programme and the design is very much pushed towards ‘how can we make this affordable? How can we make sure that we meet the target in the programme and the waste streams that we’re gonna be producing?’* Design strategies towards WM are to a large extent determined by the aims of WM on projects. On C2, the practices included the use of cut and fills to reduce waste from excavations being sent off-site. A common practice was the specification of standardized components during the design process where the designer makes the choice of components or materials with waste in mind.

#### **9.4.3.6.2 Planning**

Planning is a key aspect of the strategies adopted to manage waste on the project sites of Company C. Planning for WM begins as early as the procurement stage for sub-contractors where considerations for WM are made and put into bids. At the project stage, planning for WM begins with a review of the designs or drawings to be able to determine avenues for waste reduction where possible. As the project Manager on Project C1 explained, *“All the sites have the same target and the planning is more how they’re gonna manage the logistics so, you draw into this “okay, brickwork, we might produce three skipfuls, now do I want three skips over that period of time, or shall I order one skip, one exchange? So, it’s more from a logistics planning and then, from that, come the reduction with subcontractors.* The project Manager for C2 suggested that a major aspect of planning is determining how to deal with soil levels or formation levels on the projects. Planning for WM on site was the responsibility of the site team headed by the project manager, who decides how to achieve the targets of requested of them.

Waste quantification forms the basis for planning for WM on company C’s projects and this involves the practices of forecasting quantities and types of wastes to be expected during the execution of projects. The common practice is to put in some percentages of waste expected based on project characteristics and information from the environmental manager. In quantifying waste, the project manager for C1: *“We’ll take a look at the project, so if you take a product such as a brick, great news, the architect has designed the sizes, so I know I’m not gonna get a lot of wastage. Is the building a regular shape? Are there a lot of punched windows? Are there lots of standard door sizes within those openings? Great news, I’m not gonna have a great waste on bricks and blocks and I will put in a percentage of about three to five percent as a general wastage on bricks and*

*blocks, based on experience, based on talking to the environmental manager (Name withheld)."*

#### **9.4.3.6.3 Governance of WM**

To ensure site teams follow the laid down procedure for WM on projects, a number of people are given specific duties concerning WM. When projects begin, the project manager ensures a waste carrier is employed to act as a waste transferor for the project. Following this, a number of people perform different tasks. This was explained by the project manager: *"Then, I have to sit down and set some targets of what we think we want to achieve in terms of waste streams and that goes into the front end of the SMARTWaste, so it's a team effort. It's a number of individuals - it's not one specific person. So, in terms of record keeping, updating the SMART management plan, that is delegated to (name withheld) and she is responsible for ensuring that everything's recorded and everything is put in in terms of the data. She receives that information from our gateman, (Name withheld) and what his role is to ensure that the right tickets are recording the right waste percentages that are going in the skip and he's also responsible for making sure that all the information on that ticket - gone to the right tip, we know the waste carrier's got the right tickets and percentage, so he is responsible for making sure that's correct. A similar governance structure was in place on Project C2 where the gate man had to check for tickets while an administrative assistant entered all data into the SmartWaste System.*

#### **9.4.3.6.4 Outsourcing of WM**

As part of the site WM strategy, some WM actions or duties are outsourced to external companies to ensure the best is achieved by the company. Commonly outsourced practices include: the management of special waste (discussed in section 9.4.3.6.5); the provision of skips for waste segregation; and the transfer of waste. Some work sections are also outsourced together with their WM requirements. A typical work section with this kind of procurement arrangement was groundworks on C1. According to the Project Manager on C1 *"all our groundworks packages, the waste is included within their subcontract, but we are, ultimately, responsible to ensure they do the checks, but as the groundworker, you sort your waste out"* (Project Manager, C1). On very big projects, it was identified that waste sub-contractors may be brought to the site to manage the segregation process.

#### ***9.4.3.6.5 Management of Special waste***

According to the Environmental Manager, in all projects within her region, she registers the sites as a special waste producing site (especially for projects involving demolition). At the project level, all special waste (hazardous waste) is handled by a specialist sub-contractor who will ensure the company sustainably manages such waste. On project C2, there was the presence of asbestos and this was managed by an asbestos specialist who supervised the digging of the asbestos and managed the process in a controlled environment. The project manager from project C1 explained the process of managing or handling special waste:

*“If we come across a significant ground contamination, and let’s say it’s a hydrocarbon, and there is a large field next to the site that ain’t doing nothing that we could bio remediate that hydrocarbon soil, I would subcontract that whole portion in terms of coming to site, handling the waste, recording it, then by remediating it and then giving it back to me in a clean condition - that would be a standalone package to a specialist - and we probably wouldn’t look to run and manage that ourselves in terms of the actual work.*

The decision to use specialist WM contractors or companies for the management of special waste helps to ensure sustainable management is achieved whereas meeting the legal or legislative demands.

#### ***9.4.3.6.6 Segregation of waste (materials)***

On the projects visited, segregation of waste was captured as one of the commonly used practices on site by providing different skips for different materials. This ensured the amount and quantities of waste taken to the landfill is reduced or segregated to prevent extra cost for landfilling mixed waste. On project C1, segregation was not done on site due to the lack of space to lay out skips for segregation. For this reason, a bigger skip was brought on site to take away waste as mixed waste to be segregated off site by the provider of the skip. Plasterboard was however segregated on the project. On Project C2, there was the provision of skips for segregation and the job of sub-contractors regarding WM was identified to end once the waste gets into the skips.

#### ***9.4.3.6.7 The reuse of materials***

The strategy to reuse waste on projects is to identify avenues for the reuse of materials (waste) or to encourage reusable materials on site. On project C1, common materials

reused were soil and the cladding (sheets). According to the project manager, a discussion was made with the provider of the cladding material on the possibility of reusing the offcuts (cut pieces). Information from the manufacturer helped site teams to know how to reuse cladding offcuts. On projects C2, reuse was encouraged through the use of mass haul to ensure as dug materials were reused on the project.

#### ***9.4.3.6.8 Storage and handling of materials***

A strategy to properly handle and store materials was identified to contribute to the WM vision on. These strategies ensured less damage was done to stored materials or components on site. For project C1, the practice included the use of level grounds and pallets for storage of materials to prevent damaging which served as a source of waste generation. Pallets were used to store bricks to prevent those at the base of the pack from being destroyed.

#### ***9.4.3.6.9 Training and Education of site team***

Training fit into the overall strategy of making site teams know how to prevent the generation of, or manage waste. Practices involved conducting on-site training and education on WM for all members of the site. On project C1, this was the responsibility of the project manager who ensured the site teams are ‘*on top*’ of things especially with the importance of segregating. Training on project C1 also included the training of the gateman who is in charge of inspecting tickets or permits for the transfer of waste. Tool box talks, signage on site and site inductions for all members of the project teams served as the sources of training and education.

#### ***9.4.3.6.10 Monitoring of waste management***

Company C uses an online portal, the SmartWaste portal, for monitoring the performance of projects in terms of waste quantities: produced; landfilled; and the percentages of segregation and recycling. At the project level, monitoring of WM is the responsibility of a number of people who handle different aspects of the process from segregation to transfer. On both projects, C1 and C2, the BRE SmartWaste system was used for capturing waste data to help the site team keep an eye on waste levels. The project manager for C2 explained how the BRE system is used “*We use the BRE SmartWaste system. what we do is, we record on there every lorry that takes or brings some form of material unto site in terms of waste, and everything is logged on there. We keep all the details including the*

*permits, we scan and update everything unto the system to monitor waste that has been generated and where they go to. All that is captured on the system which then generates our overall figures which are then used for their BREEAM assessments.* (Project Manager, C2). On C2, regular safety audits were done monthly and this also looked at environmental audits where basic checks were made on the SmartWaste data to ensure the records of the site are up to date.

On project C1, there was the production of monthly performance data which served as basis for monitoring WM. As part of the report, as the Project Manager for C1 explained, “*We get a graph that shows what our waste stream is and this helps to easily identify the trends.*”

#### 9.4.4 Approaches to WM on Projects D1 and D2

Project management teams in company D were at liberty to manage waste within the approaches and strategies determined at the corporate level. A summary of these approaches is shown in the figure below.

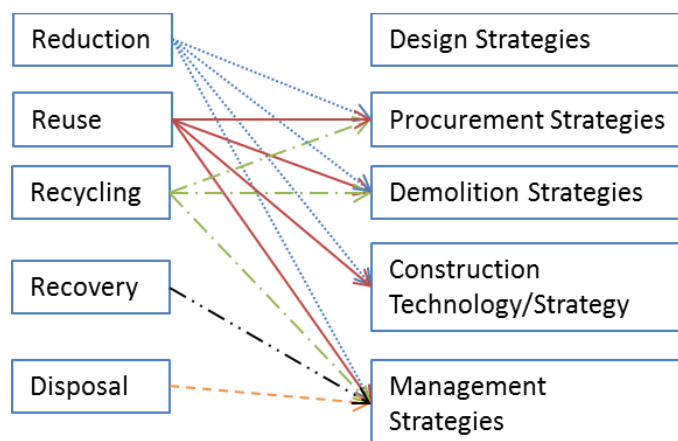


Figure 9. 11: Approaches towards WM at the project level - Company D

##### 9.4.4.1 Waste Reduction

For the purposes of waste reduction, the project teams of company D concentrate on procurement strategies construction technologies or management and demolition strategies. As the company is not involved with the design stage in most cases, approaches to waste reduction did not concentrate so much on design though the site teams recognised design as having a major influence on WM efforts on project sites. Procurement strategies concentrate on what the company considers *responsible purchasing* where site managers

and procurement managers must ensure materials with less waste generation properties are procured. Responsible purchasing also considers buying the right quantities of materials to site. The procurement process also considers selecting sub-contractors with commitment are used on their projects. Waste reduction through demolition strategies was also another approach on the company's projects and this occurred through selective demolition and deconstruction.

#### **9.4.4.2 Waste reuse**

Approaches to waste reuse take the form of management of the processes involved. Aside management, approaches towards waste reuse considers procurement where materials with reuse properties are procured. Demolition strategy was another approach used towards reuse where demolition strategies that allowed materials to be reused were used which ensured that the integrity of materials was maintained. Construction strategies that ensured materials could be reused leading to a reduction in the amounts of waste sent off the site were also encouraged by the site management teams. For the purposes of waste reduction, the company relied on managing the process of their sub-contractors and supervising their works as a means to ensure reuse. Also training through site inductions was a major approach to waste reuse promoted by the company.

#### **9.4.4.3 Waste recycling**

Due to the type of clients Company D deals with, waste recycling rates are very important to clients and the project teams have to pursue this on projects. Approaches towards waste recycling on company D's projects are mainly management oriented in terms of construction and type of demolition strategies for projects involving demolition. All recycling approaches are to ensure separate collection of waste by providing skips for different kinds of waste on site. Approaches to recycling also consider the purchasing or procuring of recyclable materials and the use of companies that are into the business of recycling materials or their waste.

#### **9.4.4.4 Waste recovery**

As suggested by the project teams, especially on project D1, waste recovery as an option is only considered when waste cannot be reused or recycled. For this purpose, the proximity of recovery stations to project sites is one factor that determines whether or not recovery as an option will be pursued. Approaches by the company towards waste recovery take the



form of management practices to ensure materials are prepared or sent for recovery. The environmental manager of the company suggested that there is waste recovery on some of their projects in the following comments: *“Of all the waste we produce on our construction sites I would say something between five and twenty per cent is getting recovered, but we don’t have a mechanism to tell us exactly that.”* (Environmental Manager, Company D).

#### 9.4.4.5 Waste disposal

Company D focuses mainly on waste reduction and recycling in most instances to ensure the amount of waste going to landfill is reduced. Though the vision of the company is to target zero waste to landfill, as seen from section 9.2.4 there is still some amount of waste sent to the landfill. The main approach towards waste disposal is management of on-site activities to ensure waste is separated at the site before being taken to the landfill. This approach also entails the management and monitoring of the transfer of waste from project sites to the waste disposal sites ensuring only authorized waste carriers are used to send waste to authorised collection points.

#### 9.4.4.6 Waste Management Practices on Projects D1 and D2

The Strategies and operational practices adopted projects D1 and D2 are summarised in table 9.8.

Table 9. 8: Summary of waste management practices on Projects D1 and D2

Waste Management strategy at project level	Summary of strategy
<b>Design to reduce waste</b>	Project teams interviewed were not part of the design team but suggested strategies such as material choice and the type of construction technology as best practices.
<b>Management structure (Governance)</b>	Clients usually set the targets or demands for WM and the senior management put in place a team for managing waste on site. Site managers are in charge of day to day management of waste on site.
<b>Planning for waste management</b>	Planning is considered as key aspect of successful project WM and centres on identifying waste sources and developing a strategy for management. Senior management on projects plan for WM with help from the environmental manager. Planning also includes initial visits before moving to site.
<b>Quantification of waste</b>	Quantification forms an important part of planning and is based on ‘guesstimates’ from experience of working with materials or particular technologies.



<b>Outsourcing</b>	The company has outsourced the provision of skips, the collection, and transfer of waste from all its projects to a waste broker. Management of special waste such as asbestos is also outsourced.
<b>Procurement arrangements</b>	Procurements arrangements are used to ensure materials with reusability are procured for working on sites
<b>Deconstructing</b>	Taking buildings apart when demolition is required to enhance reuse and recycling of waste into reusable materials.
<b>Segregation</b>	Segregation of waste on site to ensure recycling
<b>Material storage</b>	Efforts were made to store materials such as bricks on pallets to reduce to level of damage leading to waste generation.
<b>Supplier take back schemes</b>	Making suppliers of materials take back packages and pallets to ensure manufacturers recycle at points of production
<b>Management of special waste</b>	The use of external specialist contractors to manage special waste (asbestos etc.).
<b>Waste management training</b>	Site managers are in charge of training sub-contractors on projects
<b>Monitoring of performance</b>	Use of the IMS for capturing project data and performance monitoring by senior management on site. (Checking and keeping of receipts and licenses).
<b>Performance review</b>	The company reviewed performance at the end of their projects to find reasons behind performance and to help capture lessons

#### 9.4.4.6.1 Design to reduce waste

Though none of the project teams were involved with the design stage of the projects visited, the teams suggested that an involvement with the design stage makes a big difference in terms of waste generation and management on site. The strategy to reduce waste by design was identified to cover choice of materials and the choice of construction technology. As explained by the Project Manager on D1, *“When we got to the construction, it would be through the design and choice of materials, looking to reduce the waste in general.”* The project manager on D1 suggested that if the site team had been involved with the design stage and early planning of it, a lot could be prevented or saved in terms of WM.

#### 9.4.4.6.2 Prefabrication

Another strategy identified on the projects of Company D was prefabrication. This strategy according to the senior site manager on D1 saves time for construction activities on site as materials come already standardized and are just fixed in place on the site. On project D2, cladding for the enclosure of the building and steel were prefabricated. As explained by the senior site manager on D1, prefabrication of steel work ensured little waste was made on site. *“Steelwork, you’d have very little waste whatsoever because it’s a fabrication process, so they’re not bringing anything to site and then cutting it, it comes to site and it’s erected, so there’s very little waste on the steel.”*

#### 9.4.4.6.3 Design Management

Another design related strategy towards WM identified on site was design management. This strategy involves the practice of reviewing the design (drawings) to identify avenues for waste reduction and reuse. As explained by the project manager on D1, the practice of design management leads to better WM: *“on this project, it’s not been too bad. That comes down, really, to design management. If you start having a lot of mistakes at design management, then you’re going to have material to be unusable”* On project D2, this was referred to as design development. The Project Director for D2 commented on this strategy in the following extract: *“The biggest is minimising the amount of waste on site, so the architect, or the engineer comes up with a silly dimension that involves lots of cut bricks with lots of cut blocks, that’s gonna become a waste product. We try and minimise that by looking at re-positioning, or opening slightly up - whatever - so, we do utilise it.”*

#### 9.4.4.6.4 Planning for waste management

As the project manager on D1 explains: *“The success of every project is about excellent planning and I would be more than happy to admit that if you’ve got the right planning environment, good WM is a fundamental part on there.”* This comment from the project manager showed how important planning is to the site team. Strategies by Company D towards planning begin before going to the site. For both projects, senior management on site were in charge of planning and was dependent on the type of construction or project under consideration. On both projects, the company’s environmental manager assisted project leaders in planning for WM. On project D1, the general procedure for planning was *“to identify the waste sources and make sure a robust strategy is put in place for WM”* (Project Manager, D1). This also included initial visits to identify avenues for WM.

According to the project manager on Project D1, initial visits found the presence of asbestos on site (from existing structures), which the site team set a *plan* to manage. The planning process also helped to determine which part of the existing structures could be reused on site and how to handle such parts.

On project C1, planning allowed the project team the opportunity to use existing materials from the demolished building on site. As informed by the Project Manager: *“existing buildings and surfaces were reused and this made possible by putting it into the contract of the mass earthworks contractor to crush all existing (demolished) material for reuse as ground material (Project Manager, D1).”*

As explained by the project manager on Project D1, *“quantification for the amounts of waste expected on a project forms part of the planning process for WM.”* The Project Director on D2 suggested that the Bills of Quantities helps them in doing this quantification or ‘*guestimation*’. *“We use the Bill of Quantities that gives us some guidance, so you get a rough idea and if you’ve got masonry how many square metres you’ve got, you might have three/four per cent wastage, so you assume that as your basis, and that is experience... it’s our best guess, at the time, of what we’re going to do. It also, usually, reflects the budget we’ve got in our prelims for it. So, if we don’t get it right, or manage it right, we usually spend a lot of money and it’s gonna get expensive and you’ll find that I’m more focused on the cost of it.”* The data received from this quantification process forms part of the Company’s site WM plans which form the basis for managing waste on the projects.

#### **9.4.4.6.5 Management structure on site**

For company D, clients generally set the waste targets for projects and the project team has to set in place a strategy on site to meet targets. Management of activities on site was the responsibility of senior management. For Project D1, the project manager set the strategy with the help of site managers. The company’s environmental manager also helped the site team to develop the waste strategy. For Project D2, waste strategy was set by the project director and site waste managers based on the company’s procedures. The role of the project director in relation to WM was to ensure (in his own words), *that the site managers comply with our procedures in that they have got the site WM plan in place and they are using the right people and they are segregating the waste as they should* (Project Director,

Project D2). On both projects, the environmental manager for the company did waste audits periodically to ensure the site team met the demands of waste and environmental management.

Skip management on project D1 was handled by two site managers in conjunction with the company's waste brokers. The two site managers also handled the day to day management of waste including, controlling where skips are kept. On Project D2, site managers were to ensure site WM plans were in place, the right people are being used and segregation of waste. Part of their role (on both projects) is to ensure that that people keep waste in the correct skips as explained by the project manager.

#### ***9.4.4.6.6 Outsourcing of waste management responsibilities***

All WM activities relating to the procurement for skips, collection, and transfer of waste from site were outsourced to the company's waste broker. On the advantage of using this strategy, he explained *"got a better chance of making sure you're always at the front of practice, the challenge of doing it yourself is you carry on doing it the way you've always done it. They only offer to us people who are running the waste transfer station that has a very high recycling rate."* (Project Manager, Project D1). This outsourcing strategy does not only ensure waste is well managed, but also ensured legal compliance was achieved in terms of waste transfer.

#### ***9.4.4.6.7 Management of special waste***

The strategy to manage special waste in Company D was to allow qualified external personnel to take care of the process after such waste has been detected. Due to the presence of asbestos on Project D1, a plan to manage asbestos was developed where an external contractor was brought in to manage the process.

#### ***9.4.4.6.8 Demolition strategies***

For projects involving demolition works, the strategy for managing demolition is to ensure as much materials as possible are reused on the project or recycled for reuse on the project. This was achieved through practices such as deconstruction and selective demolition where the building is taken apart to ensure materials with reusable value will maintain their integrity. On project D1, stone lintels and other materials could not be reused so the demolition process was part selective where the building was pulled apart and a grabber used to pick out materials like metal (partial deconstruction). The project Director for D2

described the demolition strategy on his project as follows: *“they’ve taken the building to pieces, rather than demolished it, but in that way, you see an old base and a swinging ball, just smashing everything to bits and then a bit pile of rubble. Well, here, the machines actually select.”*

Another strategy by the company to get the best from the demolition process was *to make the demolition pay for itself*. The terms of the contract for the demolition (sub-contractors) demanded that Company D only pays 50% of the contract sum and the demolition contractor recoup the remaining 50% from sale of materials from the demolition.

#### **9.4.4.6.9 Procurement arrangements**

Procurement strategies ensured that materials with reusability are procured where possible. These included ensuring the supply chain understood WM. As explained by the project Manager on D1, having time to interrogate the supply chain to make sure they buy into the wider WM agenda affects how much can be done regarding waste. The company ensured their WM policies are taken into consideration during the procurement phase. This was made known by the senior site manager on D1: *“Before even the project starts, when they place the orders. They will be specified under Company D’s policies about waste control and WM.”* According to him, procurements arrangements consider the impact materials and even sub-contractors will have on WM on projects.

#### **9.4.4.6.10 Waste source separation**

The practice of waste source separation was to encourage reuse and recycling of waste. To do this, ‘wheeler bins’ or skips were provided close to where materials are being used or cut. This according to the senior site manager on D1 is to ensure site teams put their waste in the skips as they generated. Pointing a skip inside the building during site visits, the Senior Site Manager commented: *“With that skip there, the reason its next to there is we put it as close to the plasterboard as we can because it’s hazardous waste. If you put the skip a long way away, they’ll tend not to use it.”* This strategy was done particularly for special waste to ensure it does not mix up with other kinds of waste.

#### **9.4.4.6.11 Supplier Take- back Schemes**

As explained by the senior site manager on Project D1, supplier take back schemes are used to ensure certain waste streams are returned to their sources. This was especially used

for pallets and in some cases wrappings of materials. Some of the sub-contractors on the projects also had their own take back schemes which served as a means to reduce waste while ensuring reuse off-site and recycling was pursued. Examples of such sub-contractors were given as painters and decorators and other specialists.

#### **9.4.4.6.12 Giving materials (waste) to local communities**

Another strategy for managing waste on site was the giving away of materials to the local community instead of sending materials to the landfill. This strategy was applied to materials such as wood, which people in the local community will normally use for gardens and sheds. According to the Project Manager on Project D1 people in the community are more than happy to receive wood offcuts from the site. A policy adopted by the site was to only give away wood to people who will reuse it and not burn it. In his words: *“the truth is, in an area like this, I can put a skip of timber outside the gate and it will be gone overnight. But, I’ve been talking to the local community ‘cos they’ve been asking for wood they’ve got all sorts of ways to use it and the people right on the doorstep are the people we want to engage with. The only condition, of course, as long as you are truly re-using it ...garden sheds, community centre you can have whatever you like, but please don’t burn it, it’s still a caveat.”*

#### **9.4.4.6.13 Reuse of existing materials**

Reuse strategies on Projects D1 and D2 were used for reducing waste or for preventing as much waste as possible from going to landfill. As the project manager for D1 explained, for demolition waste, materials are crushed on site to allow for reuse. *“We crushed them on site here, there was a school up the road that was being demolished and we brought a lot of that material down here and crushed it on site”*. On project D1, many materials from the demolished structures existing on the site got reused. The site teams embark on reuse of waste because they are able to identify materials with value especially from demolished materials.

#### **9.4.4.6.14 Training and Education**

As mentioned before, the company was not involved with the ‘physical’ works and as such education was for the sub-contractors used on their sites. The two site managers on project D2 were in charge of WM training for staff in the form of weekly site inductions.

Subcontractors on Project D2 were in charge of their WM per their contract and that included education of their site teams.

On Project D1 however, WM training and education was provided by the senior site manager who briefs site teams on daily basis on practical WM. His work regarding WM was explained by the Project Manager in the following extract: *“on this particular project, one discipline we have been quite good at my senior site manager, with my encouragement, he has a daily briefing with all of the different kind of package managers on the project. So, he has a meeting including the groundwork, the cladding man, the brickworks supervisor and, in that forum, he will be briefing them and part of his agenda will be WM issues. Now, a lot of it will be fairly practical stuff, it will be about ‘right, we’ve got a compound there with the skips, I expect you to use the skips appropriately.’”*

#### ***9.4.4.6.15 Waste monitoring strategies***

Monitoring of WM performance was the work of the company’s senior management team put in charge of the project. Monitoring strategies were to ensure in the first place, compliance with legislation, and then to ensure site teams got things right by managing their activities. On project D1, all sub-contractors used were required to get their own permits/licenses which were checked by the senior site manager. For D2, the senior site manager had to take copies of receipts of all waste sent from site and also waste transfer receipts from the sub-contractors used. The strategy required the senior site manager to be on site constantly to pick out issues such as non-performance. The monitoring strategy also ensured a system was put in place ensure compliance.

On project D2, there was monthly project review meetings where waste performance was one of the major areas discussed.

#### ***9.4.4.6.16 End of project review of waste management performance***

On the projects of company D, the last WM practice was the review of WM performance at the end of the projects. This according to the Environmental Manager presents the opportunity to look into detail and think back on what has been achieved. This practice ensured the site team have the opportunity to look back and identify deficient practices which prevents the sustainable management of materials on site are prevented.



## 9.5 WASTE STREAMS AND MANAGEMENT OPTIONS

This section presents some common waste streams identified on the projects and the WM methods or practices adopted to ensure they are sustainably managed.

### 9.5.1 Waste streams and management options company A

A summary of the waste streams identified on Projects A1 and A2 is shown in table 9.9. Waste generation rates differed from the two projects as project types, sizes, and stages differed (at the time of data collection). A general link was identified between the stage of a project and the streams and quantities of waste generated. The bigger the size, the more the waste streams and vice versa. The type of construction such as steel, wood, or concrete has a high impact on the waste streams generated.

On the two projects used for this research, Project A1 was identified to have a lot more waste streams due to the type of project and the stage as at the time of data collection.

Table 9. 9: Waste Streams and management practices - Company A

Waste stream	Waste type	Management options	Project
<b>Demolition waste</b>	Demolished bricks	Reused as retaining wall for roads As replacement for quarry in making gabion walls for makeup levels	A1
	Demolished concrete slabs	Reused as hard-core during grounds works Reused for other phases of work	A1 A2
	Tarmac planings	Used under new roads	A1
	Stones from tennis court	Used as quarry for other sections of the work	A1
<b>Excavation waste</b>	As-dug materials	Backfilling behind gabion walls	A1
		Crushed and reused on site	A2
<b>Construction waste</b>	timber offcuts	Reused and segregated for recycling	A1
	Roofing sheets	Use of standard sheets prevented the need for any cutting on site	A1
	Pallets	Segregated, to be carried away by suppliers	A1
	Cladding	Use of cutting sheds to ensure segregation and reuse	A1



	Wood waste	(in some instances) Giving away for reuse by local community	A1
	Cladding offcuts	Reused and segregated for recycling	A1

As seen from table 9.9, waste reuse, segregation and recycling were the commonest waste management practices adopted managing waste on projects. All other waste quantities that could not be reduced or reused or sent for recycling were sent for landfilling. Waste recycling beyond the project sites was however not under the control of the construction companies. The companies relied on the transfer stations for percentages or recycled or landfilled.

### 9.5.2 Waste streams and management options company B

For the three projects managed by Company C, the common waste streams and the management practices applied is shown in table 9.10. Projects B1 and B2 involved demolition elements and as such more waste streams were present. During the time of data collection both projects B1 and B2 were very advanced compared to B3 and as such more waste streams were present.

Table 9. 10: Common waste types and management practices on Projects B1, B2 and B3

Waste stream	Waste type	Management options	Project(s)
<b>Demolition waste</b>	Demolished bricks	Reused as base for roads	B1
	Demolished concrete slabs	Reused as hard-core during grounds works Reused for other phases of work	B1 B2
	Stones from tennis court	Used as quarry for other sections of the work	B1
<b>Excavation waste</b>	As-dug materials	Backfilling for made up levels	B1,B3
		Crushed and reused on site	B2
<b>Construction waste</b>	Timber offcuts	Reused and segregated for recycling	B1
	Roofing sheets	Use of standard sheets prevented the need for any cutting on site	B1
	Pallets	Segregated, to be carried away by suppliers	B1,B2,B3
	Wood waste	(in some instances) Giving away for reuse by local community	B1
	Cladding offcuts	Reused and segregated for recycling	B1

### 9.5.3 Waste streams and management options company C

The common waste streams identified and the management options applied on Projects C1 and C2 is show in the table 9.8 below.

Table 9. 11: Common waste types and management practices on Projects C1 and C2

Waste stream	Waste type	Management options	Project
<b>Excavation waste</b>	Soils	Remediated and reused	C1,C2
<b>Construction waste</b>	Ground works waste	Recycled or segregated for recycling by sub-contractors in charge	C2
	timber offcuts	Reused and segregated for recycling	C1

	Pallets	Segregated, to be carried away by suppliers	C2
	Cladding	Patched and reused	C1
	Timber offcuts	Reused on site	C1
	Drainage	Reused on or off site	
	Electrical cables	Segregated for reuse/recycling	
	Asbestos	Removed by a specialist company	C2

### 9.5.3 Waste streams and management options company D

Due to the demolition aspect of both projects D1 and D2, demolished bricks, demolished concrete foundations, and concrete yard slabs from existing buildings were common waste types. The waste types generated on the two projects the management practices are summarised in the table 9.12

Table 9. 12: Types of waste generated and associated waste management actions

Waste stream	Waste types	Management actions	
		Project D1	Project D2
Demolition waste	Demolition waste		
	Demolished bricks	All crushed and reused as grounding material	Crushed for reuse on site
	Concrete foundations		Recycled into 6F2 to be used as build up material
	Concrete slabs		Recycled for reuse
	Tarmac	Planed and reused	
	Brass	Stockpiled for recycling	
	Metals	Taken off site for	

		recycling	
	Copper		Recycling
<b>Excavation waste</b>	Soils from existing garden	Part kept on site for reuse (part taken away due to lack of space)	Reused
<b>Construction waste</b>	Timber		recycling
	Reinforcement bars		Collected for recycling
	Timber pallets and stillage	Manufacturer takes back	
	Plaster board	Segregated into specialist waste	
	Timber	Segregated for recycling	Protection materials reused from floor to floor
	Protective wrappers	segregated for recycling	
	Total volumes of waste recorded during case study visits	26.33 tons of construction waste 106.5 tons of demolition and excavation waste 95.5% recycled	

## 9.6 FACTORS INFLUENCING THE OUTCOME OF WM ON SITE

As gathered from all the 9 case study projects, beyond the drivers known to influence waste on sites, a number of factors were identified to influence the extent of waste management and the level to which sustainable waste management achieved. This section discusses the factors influence the extent of waste management.

Figure 9.12 shows a combination of factors identified on all 9 projects known to directly or indirectly influence the outcome of WM. These factors include: the ability to make corporate agenda influence project level WM; availability of resources; attitudes of site teams towards WM; attitudes of senior management on site; the ability to identify avenues for WM; the type of construction technology used on-site; standardization of components; complexity of design forms; relationship with manufacturers; programming of works; size of project; understanding of the demands of WM; availability of space on-site; early planning of the project; the level of WM education on projects; and the stage of projects.

### 9.6.1 Type of construction technology

The type of construction technology used for a project was identified on all projects to affect the extent and results of WM. Construction technologies such as steel framed construction, off site prefabrication and modular construction (all referred to as low waste construction technologies) were identified to positively affect WM on projects as they led to low waste generation. On project A2, precast columns were used which according to the assistant site manager, saved on waste and time. Pointing to a precast member he suggested, *“these come in off the back of a wagon, we pick them up and drop them into place, fix the steeling - off you go - make sure they’re plumb and you can see they’re propped there whilst they set them up - off you go - next floor. Pre-cast is the way ahead.”*

## WASTE MANAGEMENT AT THE PROJECT LEVEL

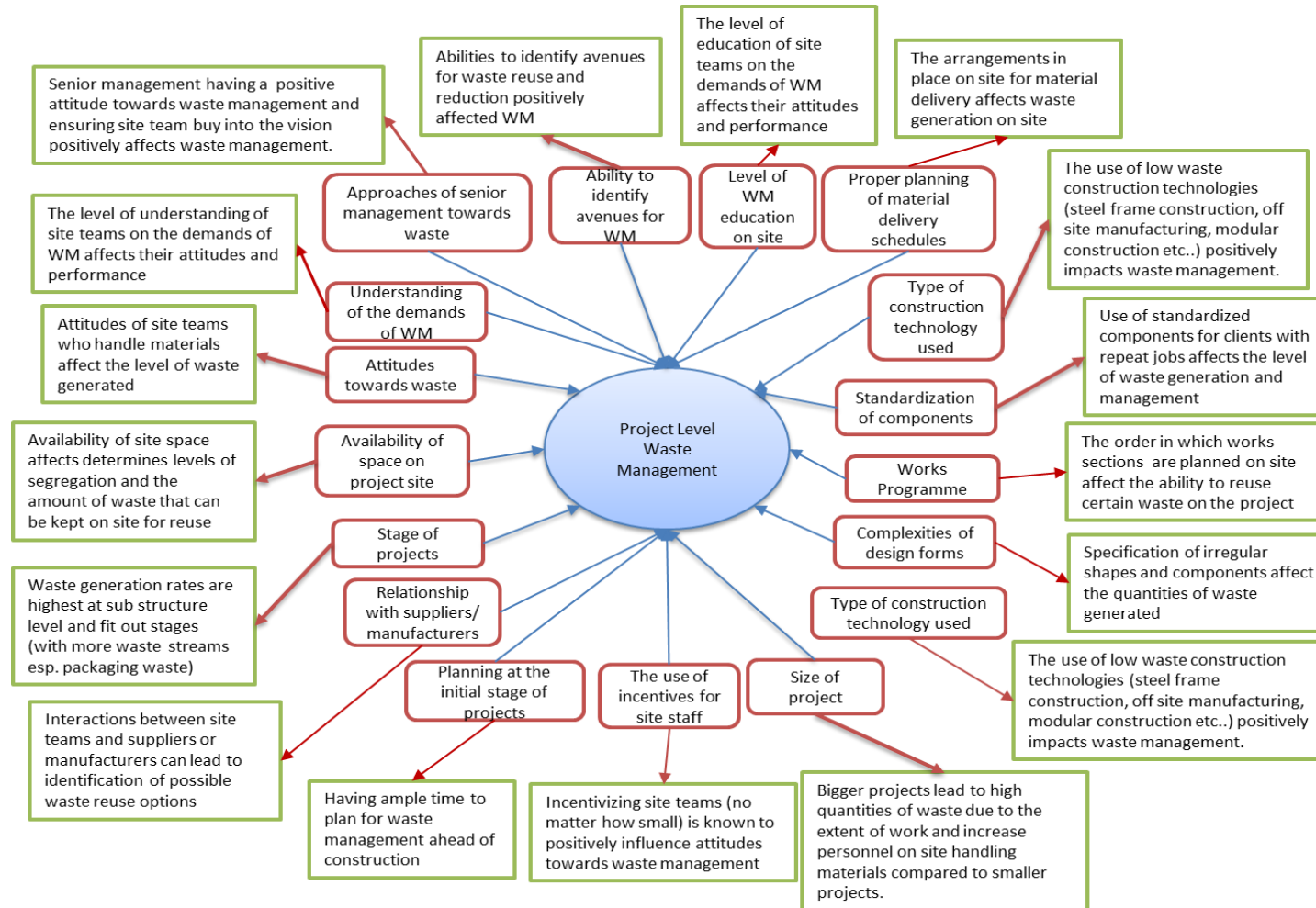


Figure 9. 12 Influences on the outcome of WM



Figure 9. 13: Low waste construction technologies leading to quick easy assembly on site with little waste (Project A2)

### 9.6.2 The Stage of a project

The stage of a project (progress level) was another factor that affected WM options and demands as different waste streams were identified. From the two sites visited, it was evident that most waste (different waste types) is generated at the initial stage (during excavations and earthworks as well as the fit out stage where there are many packages being brought to site. Projects A2, and D2 were at sub-structure level for majority of the sections on the site and this meant there was not much in terms of variety of waste. For this reason, there were no skips for segregation of waste as the ground works sub-contractor held the responsibility to manage waste from their activities.

### 9.6.3 Availability of space on site

Availability of space on site was identified to affect strategies towards the reuse and recycling of materials. Availability or otherwise of space on site affected the segregation of waste and storage of materials for reuse. Though both projects had space enough for providing skips for segregation, there was not enough space on site for the storage of all as-dug materials on project A1 and a large percentage of this which could be used on site had to be taken off site. On Project A2, the availability of space allowed materials to be kept on site for crushing and reuse



Figure 9. 14: Demolished concrete kept on site for reuse – Project A2

#### 9.6.4 Project Size

The size of projects was also known to affect the performance in terms of WM. There were two storylines concerning the relationship between size of a project and WM. Whereas small sites are generally not the best in WM, due to limited number of waste streams; and limited resources to manage waste, big projects involves so many people and factors making it difficult to manage everybody. The Assistant Site Manager for B2 explained the problem with dealing with big sites. *“It’s very frustrating when you see things happening on a job and you know there’s better ways of doing it, but the problem with big jobs like this is that it’s very difficult to change things quickly There’s so many people involved, so many people want their say, it’s very difficult to make it happen”*

#### 9.6.5 The approach of senior management towards workforce

Evidence from the site visits and interview suggest that, the relationship or approach of senior management on site towards the management of workforce affects WM to a large extent. This suggests the importance of the workforce in the project meeting its WM goals and targets. Maintaining a close relationship with the site team (hands on people) has a great effect on the WM as identified on company A’s projects. This according to the Site Manager on project D1 allows you to be able to understand them and why they do certain things the way they are. He explained his approach to ensuring a good relationship in this extract: *“so, I talk to everybody and I talk to everybody in the same way as well. Alright,*



*you have to deal with the client, but that's part and parcel of the job, but the real trick is to be able to communicate with the guys on site. A director, years ago - he wasn't very old - he said to me 'if you can look after the people, the job will look after itself' and I think there's a lot of truth in that. It's technical and there's detail, but if you keep the people happy, then they'll be happy to work for you. It's about building relationships."*

#### **9.6.6 The use of incentives**

The use of incentives on site was identified to have a big influence on WM practices on site. For this reason, on Project A2, the site management team run an incentive system called don't walk by which uses a carrots and sticks approach to reward people who perform well with coupons whereas those who perform poorly are punished. He explained the practice in the extract below. *"what we do is we issue prizes and rewards for people based on the Don't Walk By. One of the most successful things is breakfast vouchers, which don't cost us very much, but what you can do is you can say to someone 'well done, you're doing a good job, thanks for doing that' and you can give them a voucher to go and get a free breakfast. And then, the other side of the coin is that we operate something similar to a driving licence, so if you get nine points on this site, you're excluded, you're not allowed back on site. Similarly, if we had segregated waste of metal and you saw someone keep putting wood within the metal skip, you could potentially give them points. - Sustainability Environment, and Community Manager, project A2*

#### **9.6.7 Changes in attitudes towards waste**

General change in attitudes towards waste issues in the industry was identified to have its influence on site WM practices. Through the interviews it was acknowledged that more site team members are now *switched on* to the message of WM leading to a general shift/change in the industry. This shift reflects on site and according to the people interviews has positively affected WM on project sites. The Environment Advisor on B3 explained the effects of changes in industry's attitudes on site through faith in the extract below. *I think, maybe 10 years ago, people would have been a bit less understanding about the need and the importance of WM, whereas now, in reality, people understand site guides. The average member of the workforce, they understand that if you are holding a piece of metal and you're standing in front of a metal bin, or a wood bin, the right thing to do is to put it in the metal bin and I'd say that's just as a result of improvements within the whole of the construction industry in the last handful of years. This change as gathered has*

made it easier to sell the message of WM to the site team making it easier to talk to them about waste.

### 9.6.8 Design decisions

Design decisions were identified on all projects visited to have the most influence on WM on projects. Design decision such as material choices, buildability of components and shape of structures or components had an influence on how well site teams could manage well. People within site teams interviewed were of the notion that site teams belong to the tail end of the spectrum in terms of inputs in the process and decisions or actions of designers at the front of the spectrum making them deal with the consequence of the decisions of designers. As suggested by the Senior Site Manager on Project B2: *“how materials are procured and sent to us and how they are packaged, these are all things that are done away from us, so we deal with the consequences of those decisions, if you, like at site level.”* Almost all interviewees cited design decisions as a factor influencing WM on site and how using standard/simpler shapes and styles will also go a large extent to benefit WM.

Design was however said to have an influence on WM mainly at the early stages of projects where changes occur and site teams may be ahead of the design team. As identified on the projects, at latter stages of the project, design overtakes the construction where no changes occur.

### 9.6.9 Relationship between the Site team and Design team

For design and build projects, the relationship between site teams and design teams was identified as a key factor impacting on WM. As gathered from the interviews, one of the key factors affecting WM, in the first instance is to have a good relationship or coordination between the design team and the site. This helps to enable the project or site teams make inputs into the process from the practical or buildability point of view where real waste occurs. This factor was captured to play a key role considering the fact that some members of the site team consider designers to be the main source of waste generated due to the impact of design on site WM. For some members of the project team, certain design concepts are naturally susceptible to waste generation on site increasing the burden on site teams. Early involvement of the site teams which leads to coordination between the team and the design team will help the design phase benefit from the practical experience of site teams.

### 9.6.10 Ability to identify alternative use potential of materials

Being able to identify alternative uses for materials (waste) on or off the project was also a factor that affected WM. This, according to the project manager on project B1 is a major factor to sustainable management of waste. He gave an example of saving made on the project: *ability to identify a chance to reuse material from the temporary roads was able to save the project about 800 tonnes of stone* (Project Manager, B1). The Site Manager for D1 made a similar comment: *“So, what’s happened is when we dig the foundations, all the soil that comes out of the foundation went in the pond, so you’ve got concrete going in the hole and we call them the arisings and the arisings went in the pond, we were able to find use for it because we planned for it”* (Site Manager D1).

### 9.6.11 Attitude of site team towards WM

Considering the major impact of the activities of site teams on waste generation, prevention and management, the attitudes of site teams have a major influence on WM at the site level. Attitude of site teams operate at two main levels: the attitude of senior (high) level teams; and the attitude of operatives (low level members). It was gathered that the attitudes of management on project sites has a very high influence on the attitudes of low level staff and WM in general. In cases where high level management are into WM, this reflects on the activities of the other members of the site team driving WM higher up the scale. The reverse is the case where management on site do not pay so much attention to WM issues. On project B1, almost all interviewees suggested that their attitude towards waste has been influenced by the attitude of the project manager who happened to take WM very seriously and had in most cases suggested WM strategies or measures that worked positively. The kind of senior management team on site and their ability to lead by example goes a long way to affect WM practices. This according to the Senior Site Manager on project C2 is the reason why management should lead by example. He explained this as follows: *“Yes, we set the example. We’re the ones who have to enforce ... because the guys in the work phase don’t necessarily understand, or don’t necessarily know the intricacies of their contract and what they’re doing. A lot of the time, they’re just interested in making a day’s wage, so it’s up to us to educate them - which we do.”*

The attitudes of labourers and operatives also affect WM on projects and influences the levels of waste generated or segregated. This is the case as operatives are in touch with

materials and their activities generate the waste. Being fully aware of their responsibilities and the impact of their actions on waste generated goes a long way to affect WM.

### 9.6.12 Level of WM education

Education plays a crucial role in WM on project sites. As explained by the project manager on Project B1, *“ability to get the WM message into the minds of site teams or members affect WM success as it helps them get into a routine”*. From all the interviewees, education/training of the site team was the main means by which people are made aware of their responsibilities regarding WM. The willingness of site teams (especially operatives) depends to a large extent on their understanding of the demands and the real benefits of WM as this affects the extent of efforts they put into the process. A site manager on Project B3 puts it this way: *“education with regards to segregation is a major factor affecting WM on site. The ability to sell a common interest to the site team affects WM. Common interests such as cost savings and having a tidier site affects WM.”* Education and visual displays on project sites tend to drive the message into the site team. On projects B2 and B3, the environmental manager conducted regular tool box talks with pictures displayed in the canteens and common places to act as *aide memoire* to the site team. The Environmental advisor for projects B2 and B3 summarised this as follows: *“You see, a lot also depends perhaps on the level of understanding, whether they understand the full picture, or whether people explain it to them, how important waste is ‘cos the government, at this point in time, is trying to raise the fees on landfill tax in the hope that it will refrain people from dumping, but people don’t.”*

#### 9.6.12.1 Proper Signage and display of WM information on site

To help site teams in managing waste, it was identified that proper display of signage and information helped WM on sites. Especially for segregation on site, the availability of notices to help people easily identify the correct skips and put their waste correctly was a major influencing factor. One of the Site Managers on Project C2 simply puts it this way: *“providing bins, skips and signage so people know where to put which materials makes a big difference. Generally, if you’ve got the skips there and they’ve got signage up, people are pretty good at keeping it segregated, so it’s not a massive issue, the lads are quite good.”*

### 9.6.13 Time allocation on project

The general lack of time on projects during the project execution process acted as a major factor that affected WM negatively. According to the environmental advisor on projects B2 and B3, due to the cost implications of time, sometimes it is not possible to concentrate so much on WM when time and cost are not in the favour of the site team. The Senior Site Manager on project B2 explained the influence of time in the extract below: *“due to limited time, the site team may be more centred on building and finishing the work and WM (segregation of waste happens does get in their way).”* Though the research did not continue to the end of any of the projects, it was suggested by project teams that the closing stages of projects produced a lot more waste because there is hardly time to concentrate on WM.

### 9.6.14 Motivation of site teams

As gathered from the interviews, majority of site team members (especially operatives) do not see the real benefits of managing waste especially segregation of the waste. For this reason, education and incentives play a key role to make such people see the need for WM. Extract from an interview with a brick layer on Project B2 suggests that it is easier to throw things away than manage them and this is a more reason why people should be motivated to go the extra mile of managing waste. In his response to the role of incentives he made this known. *“It would be far easier to say to someone ‘when you’ve finished with that, throw it all into that lump, away you go,’ and we move on. But, there’s nobody giving you any particular prizes at the end of the week for your WM attitude, so if they really want to get it up and going and fight for the environmental thing, there has to be a few little tickles, a few prizes at the end of the day.”* This point was also supported by a Site Manager on project B3 who suggests that regardless of the education you give people on site, incentives makes things easier. In his words, *“I think, if I were to be brutally honest, I think no matter how much you choose to train some people, if they can’t see pound notes going into their pocket off the back of it, they won’t do it. I’m not saying that we should pay people to do it, sometimes it’s a very short sighted incentive and sometimes that’s the only incentive that seems to work.”*

### 9.6.15 Proper planning at the initial stages of the Project

Proper Planning at the initial stages of the project is one factor that was evident to affect WM to a very large extent. Among other things, site teams suggest it prevents issues such

as rework. As the Senior Site Manager on project B2 suggested, *“more can be done or the main work must be done outside the site; people’s decisions prior to the site team arriving on site have a big role to play on the success of WM; people like designers.”* This point was re-echoed by the Project Manager on D1 who suggested planning plays the most critical role in WM. According to him, *“if we spend a lot more time planning and getting things done properly from the start, we’d build a lot quicker, we’d built a lot more efficiently and we’d have then reduce the waste. So, this is why we’ve got a job like this, that’s been badly started, badly planned, poor co-ordination, poor communication, lots of other different regions have issues that all culminate in a job now being six weeks late - why is it six weeks late? We’re working to a drawing, he hasn’t changed the drawing yet, and we’ve actually bought it about a week ago, so things like that happen.”* From this and other interviews, it was identified that planning, coordination and communicating between the design team and the building team on site helped impact WM on site.

#### **9.6.16 Complexity of design forms and components**

The specification or design of very irregular shapes or components, was identified to affect WM on projects. Such components require a lot of cuts and this invariably leads to the generation of off-cuts which if not well managed can easily lead to waste. During the site visits on project C1, there was the construction of a platform with very irregular shapes which was cited as a typical example of a source of waste on projects. The project team however ensured waste generation was minimized by looking out for avenues to reuse offcuts from that process. Irregular design forms or shapes were identified as a client issue which affects WM. As explained by the environmental manager for the company during a tour of project C1, some clients do not understand the subject of design or component shapes and waste *“you get clients who just don’t understand the concept and design - a circular building - and want BREEAM very good and sign up to the fact that if they don’t get BREEAM very good, they’re not gonna get the funding for the project. So, when you say ‘well, you’ve got a circular building, there isn’t a straight line in here, there’s no way you can achieve that on the waste.’ And they just don’t get that interface at all.”* Such design forms or types affect waste and the ability of the contractor to educate the client helps in this regard.

### 9.6.17 Relationship between site team and suppliers (Manufacturers)

On Project C1, it was identified that communication with the supply chain especially with designers is one of the factors that help to improve WM. The Project Manager on D1 discussed how this improves WM in the extract below *“Our supply chain, working down the supply chain ‘cos obviously we also get stuff such as manufacturing offsite. They talk to us a lot ... ‘why don’t you use these standard coupons? Not only does it save you money, it’s reducing waste.’ And so that is discussed at design and contract stage*

## 9.7 CHAPTER SUMMARY

Chapter Nine has presented results from the project level of companies which suggests the level of WM achieved on projects depend to a large extent on the ability of corporate level WM strategies to influence project level practices. In most instances, vision for WM at the project level is determined by the senior management on the projects and this in some instances led to differences between project level and corporate level WM vision. Though similar drivers were responsible for WM on all projects, the extent of drivers also differed from one project to the other and this was determined by the type of project, size and the type of client. The most influential drivers at the project level were: economic considerations; and client demands. Similar approaches to waste management were also identified on all projects and included: design strategies; procurement strategies; demolition strategies; construction technologies; and management strategies which led to waste reduction, reuse, recycling, recovery and disposal. Common design practices towards WM are design to reuse existing materials, prefabrication, and the use of standardised size materials. For procurement, common practices included: outsourcing of WM to specialist companies (for special waste); purchase of reusable materials; and supply take back schemes. During the construction and demolition stages, practices such as: segregation of waste; use of cutting sheds; selective demolition; deconstructing; recycling of demolished materials; use of IMS for monitoring of WM activities; better material handling processes; use of charging scheme for sub-contractors; and training of site teams were all common practices towards WM. In all the projects, waste recovery had the least consideration compared to other demands of the waste hierarchy.

A number of factors were also identified as inhibitors or promoters for sustainable WM and these included: the type of construction technologies adopted; standardisation of



components; the size of the project; the stage of the project; the relationship between site teams and suppliers; the availability of space on site; level planning at the initial stage of projects; the use of incentives for site teams; works programme; understanding of the demands of WM; proper planning of material delivery schedules; approaches of senior management towards waste; attitudes of site teams towards waste; ability to identify avenues for waste reduction or reuse; and the level of waste management education on site. The next section discusses the results and their implications for sustainable CD&E WM.



## CHAPTER TEN

### DISCUSSION OF RESULTS

#### 10.1 INTRODUCTION

Following the presentation of findings from the research on WM at both corporate and project levels within the companies in chapters eight (8) and nine (9) respectively, this chapter discusses the results from the research involving all four companies and the implications for sustainable WM within the construction industry. The chapter discusses the results in four main sections. It begins with a discussion of the results on corporate level WM. This is followed by discussion of the results of waste management at the project level. The third section discusses the relationship between corporate level and project level WM whereas the final section of this chapter discusses the implications of the results for sustainable WM within the construction company.

#### 10.2 CORPORATE LEVEL WM

As gathered from the analysis of all four case studies, WM at the corporate level is initiated by a number of factors which drive companies to manage waste. The drivers for WM have influences on the vision for WM which determines the approach and strategies of companies towards WM.

##### 10.2.1 Drivers for waste management

From all case studies, the drivers for WM at the corporate level of construction firms can be grouped into 11 main factors as shown in the table below.

Table 10. 1: Drivers for corporate level WM in the construction industry

Internal drivers WM	External Drivers WM
Economic consideration	Client demands
Company vision	The need for benchmarking
Company Image	Government Legislation

Concern for the environment	Requirements of standards
Moral and social imperatives	

#### 10.2.1.1 Internal drivers for WM

Though similar drivers were responsible for WM in all companies, the extent of influence on WM differed from company to company. This notwithstanding, economic considerations served as the most important driver for WM within the companies buttressing findings of research reported by Hao *et al.* (2010). For the construction companies used for this research, waste generation and disposal on projects come with a huge economic burden and the ability of WM to lead to a reduction in this cost served as the most critical driver for them to manage waste. For some companies, the cost of waste was as high as 0.5% of company's total turnover and to cut down this cost means a reduction in the amount of waste generated on projects or sent to landfill.

Another very important driver for WM was identified as company environment or sustainability agenda. Due to current trends in the industry and the general move towards sustainable development, a number of companies have as an agenda to be sustainable and environmentally friendly to prove they are good builders. As gathered from the research, though cost was the most important driver for WM, corporate vision for WM served to push companies to manage waste even in situations where the cost may outweigh the benefits. Sustainability or environmental agenda springs from concerns for the environment which is reported in the literature to be responsible for beyond compliance behaviours of firms. This driver causes construction companies to manage waste even when the economic returns cannot be easily seen or is not positive. As reported in Toms (2002), companies in sensitive environments have social pressures playing crucial roles in environmentally driven practices. It was therefore not surprising that environmental concerns emerged as a driver for WM. The expectation of caring for the environment also makes WM a moral and social concern. Referred to as *social licence* in Gunningham *et al.* (2003), such public expectations for environmental performance is responsible for beyond compliance practices of many firms. The impact of waste generation on natural resources and on the environment through pollution makes firms want to manage waste as a social and moral concern.

In line with sustainability or environmental agenda of companies is the need to have a good image as a responsible construction company. Having a good image helped

companies to win contracts from clients who are environmentally aware and have interest in sustainable development (being green). Results from Thomson *et al.* (2005), suggests that a bad reputation can result in loss of market. Good image for WM performance could therefore be linked to the economic incentives of managing waste as it could convert to winning projects for the companies.

#### **10.2.1.2 External drivers for WM**

A number of other factors were identified that are external to and outside the control of the companies. For external factors driving WM, client demands, benchmarking and government legislation were known to be the most important drivers. The most critical of all external drivers, was identified to be client demands and this is because the construction industry works on the basis of executing projects for specific clients who initiate the process in any contract. This makes the demands of clients a very important role in driving WM (Yuan and Shen, 2011). As reported in Begum *et al.* (2006), clients are more interested in the economic benefit of WM on their projects. Three main kinds of clients were identified in this regard: environmental or sustainability inclined clients who are keen on WM; clients with interest in WM for the purpose of ‘ticking the box’; and clients who only had interest in completing their projects to quality, time and within budget. Though clients are generally thought of to have less regard for the environmental burden of their projects (Yuan and Shen 2011), results from this research suggests there are increasing numbers of clients who have genuine concerns for environmental and sustainability issues. Environmental and sustainability aware (inclined) clients were identified to have the most influence in driving sustainable WM on projects. Demands of search client included: the requirements for good/excellent BREEAM scores. Such clients also influence contractors’ pursuit of a good image with the expectation of winning projects or contracts from such clients.

The need for benchmarking performance against other players or competitors in the industry drove companies to manage waste. Similar results are presented in Yuan *et al.* (2012) who reviewed existing studies in construction and demolition WM. Due to current pressures in the industry to reduce the negative influence of construction activities on the environment (Esin and Cosgun, 2007), construction companies want to show they are doing better than their competitors. This suggests that competition drives WM both for clients and for contractors.

Contrary to results from research by Osmani (2012) and Yuan and Lu (2010), research participants were of the view that legislation was not a very strong driver for WM within their companies. Legislation played a secondary role in driving WM. As gathered from all the companies used in this research, prosecution for non-compliance with WM legislation gives companies a negative image and this is the main reason why construction companies are very particular about WM legislation. Some interviews from the corporate level of construction firms suggested that current trends in the industry require the contractor to list all issues of prosecution when bidding for jobs and any such issues served as a 'black mark' which could be the difference between winning and not winning a contract. For this reason, construction companies are more interested in complying with government legislation to ensure they do not get negative publicity. Beyond image, the high cost of disposing mixed waste at landfills as a result of the Landfill Tax served as a driver to manage waste sustainably. This made the Landfill Tax the most important legislation influencing WM. Results from Seeley (2009), Davenport (2003), Martin and Scott (2003), and Morris *et al.* (1998) all suggested similar. There was however mention of the Site Waste Management Plans (SWMP 2008) Regulation as an important legislation as it had influences on waste generation and management on-site. This legislation however was scrapped at the time of data collection and some interviewees expressed their disappointment in the repeal of the SWMP 2008 Regulation. According to some interviewees, the SWMP Regulation drove even smaller firms to manage waste and was a good means to tackle fly tipping.

WM Standards such as ISOs and other schemes or commitments construction companies are signatories to, also serve as drivers for WM. From the research it was identified that such commitments required construction companies to manage waste to meet certain expectations. Examples of such schemes are the Halving Waste to Landfill initiative of WRAP and the Considerate Construction Scheme, which according to Barthorpe (2010) and Glass and Simmonds (2007) helps to raise the environmental awareness of constructions firms.

All the drivers of WM were identified to align with the requirements of sustainable waste management reported in the literature (See Yuan, 2012; Yuan and Shen 2010; Chidirolou *et al.*, 2008; and Chung and Lo, 2003). The drivers discussed above influenced the WM vision of construction firms making sustainable CD&E WM a common goal in the industry.

### 10.2.2 Vision for WM

All four companies had WM visions underpinning their WM efforts. Though there were minor differences in the visions of the companies which were simply cosmetic and semantic, all four companies targeted sustainable management of waste and this can be attributed to the drivers as discussed above. The visions for WM were also fuelled by values such as: the belief in WM as the means to reduce pollution prevention from the construction industry; inefficient resource use as the main source of waste generation; and the role of senior management; sub-contractors, designers and clients as part of the solution to waste management.

All companies used in this research acknowledge the negative influence of the construction industry on the environment and pursue WM as part of their agenda or vision to reduce the negative influence of their activities on the environment. As reported in Udawatta *et al.* (2015), there is increasing pressure on the construction industry to reduce the effects of their activities on the environment. From the drivers, vision and values influencing WM, it is evident that WM is well recognised as a very important aspect of ensuring the negative influence of the industry on the environment is reduced. In relation to WM legislation, it can be argued that the visions of construction firms for WM align with the intended outcomes of government legislation on waste. All the drivers dictating CD&E WM relate in one way or the other to: cost reduction; environmental concerns; and social concerns which are the three key goals of government legislation on waste.

### 10.2.3 Approaches to waste management

The visions for WM determined the general approaches firms adopted to manage waste. These approaches are grouped into approaches at: design; procurement; and construction phase.

#### 10.2.3.1 Approaches to manage waste through design

Studies by Jallion *et al.* (2009), Osmani *et al.* (2008) and Ekanayake and Ofori (2000) all report that design has influence on waste generation and management. It was therefore not surprising that the design phase of projects was identified to have the maximum influence on WM. For this reason design received the most attention from case study companies, especially companies involved with design of projects. Though the approaches towards design differ from one company to the other, the main aim at the design stage is to reduce

waste generation on projects or prevent waste from occurring in the first place which is one of the aims of government WM legislation. The different approaches towards WM by design can be summarised into: the principle of designing out waste; the principle of resource efficiency; the specification of materials with low waste generation or environmental effects; and early involvement at the design stage to encourage waste reuse and reduction.

Approaches to reduce waste by design also include the adoption of technologies such as modular construction, pre-cast and off-site manufacturing options which are reported in the literature as very effective means to reduce waste (See Jaillon *et al.*, 2009; Cosgun, 2007). Another approach to WM at the design stage is to involve the site team or the construction company early at the design phase. This was especially so for companies not involved with the design of projects to ensure the construction teams could make inputs for the purposes of buildability and waste reduction. This was however not possible for projects where the traditional approach to contracting was adopted where contractors only bid for projects after the design phase.

#### **10.2.3.2 Approaches to WM through procurement**

Two main approaches were adopted for the purposes of procurement: responsible sourcing of materials; and the use of preferred suppliers or sub-contractors. These approaches relied mainly on supply chain arrangements to select sub-contractors who favoured the vision of the company concerning WM and were compliant with government legislation buttressing the role played by sub-contractors in ensuring sustainable WM is achieved. For this reasons all companies had a means to filter their sub-contractors to achieve what is referred to as a '*preferred list*' of suppliers. Though sustainability or WM was not the number one prerequisite to be on such preferred lists, for companies that have high requirements for environmental performance or sustainability, this formed a major requirement. The approach of responsible sources with regards to materials targeted ensuring only specified materials (in terms of quantity and quality) make it to the project sites. Begum *et al.* (2007) suggest that attempts should be made at the procurement stage to ensure reusable or recyclable materials are purchased. Responsible sourcing feeds into such attempts with the aim of preventing waste generation and encouraging reuse.

### 10.2.3.3 Approaches to WM at the construction stage

The approaches to WM at the construction phase of projects varied from one company to the other though the focus remained on reducing the amount of waste generated, reusing waste, preparing (segregating) waste for recycling, preparing for recovery (in a few instances) and proper disposal. Corporate level approaches towards the construction stage seek to ensure site teams make the most influential decisions concerning WM by looking for avenues to reduce waste for all excavation, demolition and construction activities. A common trend was the approach to ensuring site teams used the waste hierarchy as the preferred means of ensuring waste is sustainably managed on-site. This was mainly pursued through managerial guidance for site teams to make them understand what the requirements for WM on the projects were, and collaboration with suppliers and sub-contractors to ensure WM is sustainably pursued.

The approaches towards WM at the project phase ranged from the management of sub-contractors, to the management and education of company site teams. For some companies, this included construction technologies and methods that lead to less waste generation on projects and encouraged the reuse and recycling of waste from projects. Other companies relied on the use of what was referred to as '*resource management plans*' to ensure resource efficiency measures were adopted which made the best use of the resources available on their projects sites.

To ensure the approaches towards waste management had influence on projects, operational strategies were designed by the companies to convert the approaches into actions leading to waste management practices.

### 10.2.4 Strategies towards WM at the corporate level

The strategies adopted to convert approaches into actions are divided into: planning; governance; outsourcing; monitoring; and training and education as discussed below.

#### 10.2.4.1 Planning

Planning begins as early as the design stage for design and build projects, and mobilizing stage for traditional projects where contractors are not in charge of design. The basic principle in planning for WM is to ensure consideration is given to waste before construction commences. As reported in Poon (2007), strategic or early planning played a very influential role in minimizing waste on projects. Results from the companies suggest

that planning gave the company the opportunity to decide what to do with waste arising from projects. All planning for WM on projects was made with reference to the waste hierarchy. For design and build projects, planning requires design teams to give consideration for preventing waste by design through the adoption of options that favour waste reduction and encourage the reuse of materials. This also included designing or choosing standardized elements or components in the designs to reduce the amount of off-cuts coming out of the design phase. At the mobilization stage, planning involves forecasting the amounts of waste expected on projects to ensure the best strategy is put in place. Waste management plans or resource management plans formed the basis for planning. Though no more a legal requirement, site waste management plans (SWMPs) formed an integral part of planning in the companies.

#### **10.2.2.2 Governance of waste management**

A key means of ensuring efficient WM within construction companies relied on having a well-defined structure in place at the corporate level for managing waste. All the companies used for this research, had management teams for ensuring waste was given the required attention at the corporate level. The governance structure differed in terms of complexity and this was based on the size of the company, and the relevance they give to WM. Roles such as: Sustainability Director; Chief Sustainability Officer; Head of Environment; and Environmental Manager were common titles for people with the highest responsibility for waste in the companies. Their roles generally required them to have oversight responsibility of company environmental management or sustainability efforts. In every company, there is a sustainability team or environmental team who are in charge of setting and reviewing targets for WM at the corporate level and in charge of determining corporate level approaches and strategies towards WM. The governance structure has responsibility for planning waste management.

For the purposes of project level waste management, the governance structure was in charge of pointing project teams in the right direction while serving as auditors to ensure the corporate level vision is pursued.

#### **10.2.4.3 Outsourcing of WM responsibilities**

As part of the strategies towards managing waste, some responsibilities are outsourced by the construction companies. Though similar responsibilities are outsourced, the extent of outsourcing depended on a company's own vision and project level features. Key



responsibilities outsourced are the provision of skips for segregation, the transfer of waste from site and the management of special waste (hazardous waste). For all the companies involved in this research, it was identified that skip provision and waste transfer are key responsibilities outsourced. In some cases, outsourcing went beyond just the provision of skips and the transfer of waste from site to include the segregation of waste on-site. This form of outsourcing was however dependent on the size of projects. On very large projects, a company may decide to outsource waste segregation on-site where a WM company would be on-site to ensure the segregation of waste on-site is duly done. This strategy was deemed to be beneficial where projects were so large and the waste streams so many that it would take the construction company's site team too many man hours to segregate waste.

Another strategy towards outsourcing WM in one company (Company D) was the use of a waste broker who had the responsibility for providing skips for all projects handled by the company. This outsourcing strategy was used by the management contracting company who suggested the strategy of outsourcing the search for skip and waste transfer to single company saved them time to focus on other things. This strategy according to the company, helped to ensure only firms compliant with legislation were dealt with.

In all four companies, the responsibility to manage special waste was outsourced and this was identified to be as a result of the legal requirements for managing such waste. To ensure compliance with legislative demands, all companies ensured the removal or management of asbestos was outsourced to specialist contractors who have excellent knowledge on dealing with asbestos.

#### **10.2.4.4 Training and education**

Ensuring project teams understand WM requires training and education and for this matter each company has a strategy to ensure site teams have the required knowledge and understanding of company WM requirements and are equipped with the necessary skills needed for ensuring waste is sustainably managed. Wang *et al.* (2008), report that instituting training and education is an effective way of managing waste. Begum *et al.* (2007), also report that training is an integral part of strategies towards WM. Training and education took two main forms: on-site through the companies' environmental advisors or project management teams; and training through an e-learning platform. Site inductions or tool box talks on best practices towards WM on projects, posters and other displays on-site all contributed to training and education on WM.

#### 10.2.4.5 Monitoring of WM

Rodriguez *et al.* (2007), report that EMSs are gradually enhancing the awareness of personnel on construction-sites. For all the companies used in this research, there were systems in place for monitoring performance in relation to WM. The WM systems were very important for a number of reasons: to help review the company targets; to help know how well the company is doing in terms of WM; and to help serve as a source of information for company sustainability reports.

An integrated management system (IMS) or EMS which helped the company monitor WM as part of environmental management efforts were used. On projects, monitoring of performance was the duty of project management teams who had oversight responsibility for WM efforts. Their roles included ensuring the targets set for the project are met by the site teams. For some companies, environmental advisors served the purpose of monitoring site teams and their WM efforts and this was identified to have a positive influence on WM at the project level. Proper monitoring of WM has the ability to positively influence the outcome of WM on projects (Osmani *et al.*, 2006) and for this reason, all companies put effort into WM monitoring to ensure targets are met.

#### 10.2.4.6 Documentation for waste management

To ensure corporate level WM vision, approaches and strategies are pursued on project sites, all companies have a number of documents prepared to serve as guides to project teams. A common document was an environmental policy which is reported in Azzone *et al.* (1996), as a useful indication of a firm's (attitude towards) pro-environmental behaviour. Interestingly, only one company had a specific policy document for waste as all companies regarded WM as part of environmental management. In terms of documents, some companies relied on having detailed documents detailing specific demands and a step by step approach to be adopted on projects for managing waste whereas others produced rather generalised documents which served to point site teams what to look out for on projects. Udawatta *et al.* (2015) report that detailed documentation on WM plays a crucial role in reducing waste generation on projects. As part of the requirements to comply with WM legislation, some companies have a register of legislation to help them stay on top of legislative changes. For other companies, the documents made available to site teams have key legislation and the specific demands that affect their activities on-site.

Insights from the approaches and strategies of companies towards WM indicate a commitment to ensure the best is achieved from company waste management efforts. Training and education, the development of WM documentation and the use of WM systems (EMS and IMS) can be seen as efforts towards ensuring the companies manage waste in a well organised and directed manner. Such efforts will ensure project teams pursue company WM visions. As discussed in 8.5, a key reason for setting up corporate level WM strategy is to ensure sustainable WM which ultimately is the goal of government WM legislation. The effectiveness of the WM depends to a large extent on the ability of corporate level strategies and approaches to influence project level WM where waste is generated and managed.

### **10.3 PROJECT LEVEL WASTE MANAGEMENT**

This section discusses WM at the project level within the companies and takes into account the visions for project level WM, the drivers and approaches. This section also discusses the factors affecting WM at the project level and ends with a discussion of the waste streams identified on projects and the practices used to manage such waste.

#### **10.3.1 Drivers for project level WM**

Just like the corporate level, a number of drivers dictated to a large extent the approaches and strategies towards WM on project. Though corporate level WM vision was expected drive project level WM, the results from the project level WM however suggests that in most cases, the extent of drivers for project level WM differed from company vision. Project level waste management was largely driven by: economic considerations; client demands; company agenda; changing industrial perspectives; concerns for the environment; health and safety concerns; government legislation; and requirements of standards.

Of all the factors driving waste at the project level, economic consideration was the most influential factor on all projects. This according to the project teams (especially project managers), was due to the requirement to deliver projects within budget. The main cost elements of waste generation on projects were identified to be the cost of materials, the cost for transporting waste and the payment for landfilling of waste as reported in Begum *et al.* (2006) and Shen and Tam (2002). Higher charges for landfilling mixed waste served as the main driver to segregate waste on-site. For this reason, WM practices for which site

teams could not see the economic benefits were not favoured unless there was pressure from the corporate level. This defeats the goal of companies to manage waste for the purposes of environmental sustainable concerns.

The second most influential factor was company vision for sustainability and environment. This driver was very influential only when corporate level environmental advisors. For projects where there was no visible corporate level influence company vision did not have the level of influence expected.

For all projects, clients have the final say and for this reason the demands of the client, especially environmentally aware clients, for effective WM served as a driver for WM on projects. On some of the projects, the client requested excellent BREEAM performance and this demanded high recycling rates and low rates of waste to landfill. For this reason, site teams were driven to ensure WM met these requirements. For some other projects, the clients demanded high rates of reuse and recycling and these also served as drivers for WM.

Drivers such as concerns for the environment, company image, requirements of standards, and health and safety concerns are all covered to a large extent by company sustainability or environmental agenda/vision which suggests that efforts should be made into making company agenda have the level of influence required. Changing industry perspective on sustainability also influenced waste management. This changing perspective in the industry relates to concerns people have for the environment. Yuan and Shen (2011) identified concerns for the environment as one of two main reasons for which CD&E WM is pursued with cost being the other reasons. As gathered from the research, there are some people who naturally have concerns for the environment as a result of a realisation of the negative impacts of the industry on the environment. It was identified that where site teams had such concerns for the environment, it influenced their attitudes towards waste prevention and management.

Though government WM legislation was also identified as a driver for WM on-site, its effect on-site was not always directly felt. There was the general notion that WM legislation was not like other legislation such as health and safety where there was more interest from the government making compliance a key issue. A comment such as: *“I have never seen anyone being fined on-site for not managing waste. So yea legislation is important but not as important as it is made to appear”* supported this notion. Many

people on-site were of view that the strategies of their company have legislation covered and as such company policies were more important to them. This result confirms research by Udawatta *et al.* (2015), who suggest that in construction and demolition WM, company policies are more important than legislation.

This suggests the need for proper enforcement of WM legislation by approaches that can either partner companies to pursue a common goal, or approaches likely to detect and punish for non-compliance.

### **10.3.1 Project level WM vision**

The vision for WM differed from one company's projects to the other and even within the same company, the vision differed from one project to the other. The differences in project level vision across different companies were identified to be based on company WM vision and policy whereas the differences between projects managed by a single company were based on the preference of project or site management teams, especially project managers, who have the overall responsibility for WM. On almost all the projects the project manager or director had the overall responsibility regarding waste and environmental issues and the inclination of the project manager/director towards WM defined the vision for WM. This suggests that achieving sustainable WM on projects requires attention to be given to the awareness and attitudes of PMs and PDs when putting together project teams. To ensure PMs and PDs positively influences WM on projects, some companies have appointed waste advisors who serve as auditors and resource persons to project management teams.

Drivers and vision for waste management translated into approaches for managing waste on projects as discussed below.

### **10.3.3 Approaches and strategies towards WM**

Similar approaches were used by project teams to meet the requirements of the waste hierarchy. However emphasis and impact differed from one project to the other. These approaches were targeted at meeting the demands of the waste hierarchy by prioritising reduction, reuse, recycling, recovery and as a last resort, the proper disposal of waste. The operational strategies for realising their approaches involved: design strategies; procurement strategies; demolition strategies; construction technologies/strategies; and management strategies.

### 10.3.3 1 Waste reduction

From all the projects visited, the approaches towards waste reduction took the form of design strategies, procurement strategies, construction technologies or strategies, demolition strategies and management strategies. The application of these strategies was mediated by project characteristics and the choice of project management teams. Design strategies were adopted when the construction company or project team was involved at the design stage of projects. These included strategies to design out waste by practices such as: design to incorporate standardized sizes and components; design of regular shapes and simple plan forms; design to incorporate existing materials on-site; and design for prefabrication. Other design strategies to reduce waste was the use of cut and fills for soil levels. This is contrary to results by Osmani *et al.* (2008) who report that waste reduction is not a priority in the design process. Majority of site team members were however of the view that designers could do a lot more to reduce waste as majority of waste generated on projects is still as a result of design decisions. Some site team members (both management level and operatives), suggested that the design process should include site level staff who are in a better position to identify avenues to reducing waste by design. Design to reduce waste was however affected to a large extent by manufacturer's sizes as this limited the sizes designers could adopted.

Gamage *et al.* (2008) report that procurement methods serve as a major source of waste in the construction industry, which suggests that procurement could be looked at in trying to achieve waste reduction. Strategies in this regard encompassed ensuring sub-contractors who had good WM credentials were brought on-site, adopting responsible purchasing by ensuring only the correct quantities and qualities of materials are brought to site, and arrangements with suppliers of materials to take back their packaging and pallets. Demolition strategies such as deconstructing, and selective demolition were adopted to ensure the integrity of the materials is maintained during the demolition process. Construction technologies or strategies towards waste reduction such as: off-site manufacture of components; and the use of steel technology as compared to concrete, which led to more waste generation were preferred. Management strategies towards waste reduction such as design reviews; material handling strategies, where site teams ensured materials did not result in waste were also adopted for waste reduction.

### 10.3.3.2 Waste reuse

Approaches towards waste reuse can also be grouped into design, procurement, demolition, construction, and management strategies. Design approaches towards waste reuse were the commonest and most influential of all waste reuse approaches. These included the design for the use of materials from excavation, the design for the use of demolished materials, and the specification of recycled materials to be reused on-site. Procurement approaches relied mainly on the need to purchase materials with reusable value. Practices such as responsible purchasing and sourcing to get the right quality and quantities of materials to site contribute towards this strategy. This is in line with results from Begum *et al.* (2007) who suggest that, during the procurement of materials, attempts should be made to purchase materials which have reuse packaging or are recyclable. Demolition approaches towards reuse ensured the demolition process did not damage the integrity of materials so they could be reused on the project or on other projects. Selective demolition and deconstruction were practices that ensured materials from demolition could be reused. In some cases the demolition process ensured materials could be given to members of the community for their use. Construction technologies that favoured reuse of materials on-site were adopted. On some projects, reuse of cladding was made possible by joining off-cuts together. Management approaches towards reuse begin with project teams being able to identify reuse option for materials. Such approaches were adopted to ensure materials with reusable values were not sent away from site and included the use of cutting sheds to ensure some materials are not mixed. This can be achieved through practices such as monitoring and education on-sites. As reported in Zhang *et al.* (2005), to help reduce waste, close attention should be paid to all construction-site workers; from labourers to site managers. Performance monitoring helps to identify poor performance and make the required interventions. Training formed an important aspect of this approach.

### 10.3.3.3 Recycling

To ensure recycling of materials from projects or the use of recycled materials on projects, approaches identified on all projects took the form of design, procurement strategies, demolition strategies, construction technologies/strategies, and management strategies. Though approaches to recycling through design strategies were identified not to be very common on projects, these approaches mainly entailed specifying recycled materials as part of design. The main approaches towards recycling on projects took the form of management strategies to segregate waste, and demolition strategies to deconstruct or



selectively demolition components so they could be recycled. On almost all the projects visited, there was the provision of skips to ensure site teams segregate waste. Segregate waste at the source of production was identified to be the most influential management strategy towards recycling. There was a common misconception on almost all projects visited where members of project teams equated segregation of materials into skips to waste recycling. For many people interviewed on project sites, especially operatives and low level staff, getting materials into the right skip suggested they had recycled as the materials will be taken for recycling.

#### **10.3.3.4 Waste recovery**

Waste recovery which according to the waste hierarchy is the preferred choice for managing waste after recycling was identified to be almost absent from all projects. Of all four companies used for this research only one company considered waste recovery as an option they would pursue. The only approach used in this case was management strategies to ensure materials are prepared and sent to a waste recovery facility. The low regard for waste recovery was identified to be as a result of less recovery centres making that option not very viable to the project teams. Even for the company or project that recovered waste, it was identified that no mechanism was available to the company to be able to tell how much of its waste actually got recovered.

#### **10.3.3.5 Waste disposal**

From all projects visited, waste disposal was the last resort for waste. The vision of project teams was however targeted at ensuring as much as possible waste is diverted from the landfill. The approaches towards waste disposal on projects were all management oriented with the intention of ensuring materials are segregated and transferred to the correct landfill or to registered waste carriers who would transfer the waste to the landfill. On all projects, it was identified that charges for disposal of waste at the landfill served as the main driver pushing for management strategies to segregate waste before transfer to the landfill. Higher charges for disposing mixed waste was common knowledge for all site teams and this contributed towards the approach towards waste disposal by site teams.

#### **10.3.6 Factors influencing the outcomes of waste management on projects**

As reported in section 9.6, the extent to which the approaches and strategies discussed above lead to sustainable waste management depends to a large extent on a number of



factors. In general about 13 factors were identified to influence the extent of WM or the outcomes of WM. These factors are: availability of resources; attitudes of site teams; the ability to identify avenues for WM; the type of construction technology used on-site; standardization of components; complexity of design forms; relationship with manufacturers; programming of works; size of project; attitudes of project staff towards waste; understanding of the demands of WM; availability of space on-site; early planning of the project; and the stage of projects. These factors were identified to be interrelated and ultimately influenced the outcome of WM effort.

Attitudes of site teams, both operatives and management level, were identified to have a major influence on the extent of WM. Attitudes affect the level of importance attached to WM which in turn influences the performance of site teams concerning waste. Manewa *et al.* (2007), report that process sources such as the performance of workers has a major impact on waste generation on projects. Attitudes of senior management were however identified to have the most influence on the outcome of WM as they are in charge of driving site teams to manage waste. As reported in Hao *et al.* (2010), active participation of management will influence waste management on site. As reported in a previous research by Begum *et al.* (2007), the level of training and education on WM also influences the attitudes of site teams as it can lead to better understanding of the demands of WM. Another major factor influencing the outcome of WM efforts is the availability of resources. Regardless of the attitudes of people towards waste, the absence of resources such as skips for segregation and separation at source will defeat the expected outcome of waste management. Site space is also another factor that influences segregation as the space will be needed on site for skips if segregation on site is to be pursued.

Another factor identified to influence the extent and outcome of WM on-site is the adoption of low waste construction technologies such as prefabrication and modular construction which according to research by Jaillon *et al.* (2009); and Cosgun (2007), help to reduce waste generation. As gathered from this research, such technologies or methodologies do not only reduce waste generation, but also reduce the amount of time needed on-site for project execution. Just as identified in this research, Urio and Brent (2006) also suggest that close collaboration between designers, managers and the supply chain, can result in better waste management on projects.

## **10.4 IMPLICATIONS OF THE RESULTS**

The results from the research suggest that sustainable CD&E WM, which is the main intended goal of government WM legislation, can only be achieved when efforts are made by all the parties involved in the construction process: clients; designers; contractors; sub-contractors; suppliers; manufacturers; and waste management companies. The specific implications of the results for WM vision; WM drivers; approaches and practices towards WM; and influences on the extent of sustainable WM are discussed below.

### **10.4.1 Vision for Waste Management**

The results from the study imply that vision for WM can be effective in achieving sustainable WM if it is clearly defined at the corporate level and supported by the policies and structures in place to drive this vision unto the project. Leaving project teams entirely to determined WM vision may not also lead to the required results as vision may not fully align to corporate level vision as it will be based on the preference of project teams. This also suggests the need for taking into consideration the inclination of project leaders towards waste management into account when setting up project teams. Aligning corporate level vision with project level vision requires corporate level staff with understanding of company vision on waste management to assist project teams in some instances.

### **10.4.2 Drivers for waste management**

The most influential driver in ensuring sustainable WM is achieved is company environmental or sustainability agenda. Though this is normally the case at the corporate level, at the project level which ultimately determine which waste management strategies and practices are pursued, the most important driver is cost. Site teams are more interested in the cost savings due to waste management and when they can't see the economic benefit of certain actions, may not necessarily pursue it. To ensure the company vision/agenda remains the number one driver on projects, measures should be put in place, especially by environmental advisors to pursue waste management for the purposes of company vision which ultimately will lead to economic savings. The results also imply that all the drivers for waste management: economic considerations; client demands; company image; the need for benchmarking; concerns for the environment; moral and social imperatives; government legislation; and the requirements of standards, can be amalgamated into design of company sustainability vision or agenda. This will make driving WM by company agenda fulfil all the demands of WM.

The results indicate that current government WM legislation does not have full impact on WM, especially at the project level and this is due to the enforcement approach adopted. There is the need for a better approach to ensure government legislation yields the required level of impact on WM.

#### **10.4.3 Approaches and practices towards waste management**

For the approaches and practices towards waste management, the results imply that some of the approaches currently adopted on lead to strategies and practices that can make immense contributions towards sustainable WM whereas others do not make much contributions to sustainable WM.

The results indicate that design has the most influence on ensuring waste is prevented or reduced in the first place. The approach to waste reduction by influencing the choice of the client is one of the best means to ensure waste management is given the best consideration at the very early stages which has the maximum impact project level WM. The practice of design management can help and contribute towards better planning at the initial stage of projects. This implies efforts should be made towards implementing this approach on projects involving design. The more the effort put into the planning phase of projects, the better the approaches and strategies designed towards WM. This implies more attention should be given to the design and planning stage of projects. The use of site waste management plans (SWMP) by all the companies involved in the research though it is no more a legal requirement suggests the use of SWMPs is very relevant in achieving sustainable WM.

The use of a charging scheme as a strategy to influence sub-contractors to manage waste also has the ability to help the construction companies achieve the vision for waste management on projects. Other practices that can achieve sustainable WM include: supply take back; and buy back schemes; which contribute towards waste reduction whiles bringing back some money to the site. The results also suggest that waste separation at the source of production (such as the use of cutting sheds practiced by Company A the provision of wheeler bins at the point of waste generation) promotes waste reuse on site.

Having a laid down step by step strategy for waste management from design to construction sites lead to better waste management performance as site teams have guidance at hand for reference. Waste management performance review was identified

from other projects to create a very good opportunity for companies to capture lessons learnt from projects which can then inform corporate strategy.

The results also imply that waste management performance review at the end of projects creates the opportunity for companies to capture lessons learnt from projects which can then inform corporate strategy.

#### **10.4.4 Influences on the extent of waste management**

The results on factors affecting the extent to which sustainable WM is achieved suggest that achieving sustainable CD&E WM goes beyond the drivers for WM. The extent of sustainable WM actually achieved on projects is dependent on: the ability to make corporate level strategy influence project level strategy; senior management on projects; the operatives and sub-contractors; and the availability of resources to manage waste.

For site teams, regardless of the company policy and other drivers of waste management, if senior management on projects do not push the waste management agenda higher, little will be achieved. Senior management on site do not just affect company staff but sub-contractors who are willing to do what it takes to get repeat jobs from the main contractor. For WM targets to be met, corporate level waste management vision should influence education and training of site teams which can lead to better understanding of waste management: its importance to the company; and how their activities on site contribute towards the company's vision. Training and education should also help site teams to be able to identify waste management options (especially reuse potential of materials).

Proper planning at the initial stage of projects have a very important impact on waste management at the project stage and is an area the company may want to focus on. This includes programming works to take into consideration the use of waste such as mass haul for earth works and the reuse of materials from demolition processes. Early involvement of site teams at the design stage was also identified to influence waste management and this implies that corporate waste management strategy should ensure, where possible, that site teams are involved early at the design stage to enhance information exchange which can influence waste reduction by design.

Though attitudes towards waste management in the industry are gradually changing, the use of incentives (especially financial incentives) to motivate site teams to manage waste has proven very important and influential. The practical completion stage has also been

identified as a major stage where waste is generated due to the focus on the need to handover the project to the client as quickly as possible. For firms to reduce waste at this stage, conscious efforts must be made to ensure waste management is given the needed consideration during the practical completion stage.

## **10.5 EXTENT OF ACHIEVEMENT OF INTENDED GOALS OF WM LEGISLATION**

To be able to measure the extent to which the intended goals of CD&E WM legislation have been achieved by current practices of the construction firms, there is the need to measure current waste reduction rates against the intended targets of WM legislation. As recalled from section 5.4.2, the intended goals of government CD&E WM legislation are to ensure for the purposes of EU policy:

- to ensure 70% of all CD&E waste is reused, recycled or recovered by 2020.

Local targets in the UK are to ensure:

- 50 per cent reduction CD&E waste to landfill by 2012 in relation to 2005 levels: and
- zero waste to landfill by 2020.

According to the EU WFD, these reduction and recycling targets are to result in:

- reduction in the total volume of waste generated;
- managing waste without harming the environment and health (reduction in pollution);
- reduction in the use of natural raw materials;
- reduction in the amount of land space used for waste landfilling; and
- Ensuring economic management of waste.

The most current data on waste generation rates in the UK as presented by DEFRA in December 2015 is that of 2012. This data forms the basis for measuring the extent to which the construction industry is meeting the intended outcomes of WM legislation.

Waste generation rate for 2012 suggests that the UK generated 200 million tonnes of waste of which 50% was from the construction industry (DEFRA, 2015). This suggests an almost constant rate of generation compared to 2008 levels. The rate of generation as a percentage

of total waste produced in the UK suggests a 15% increase in the contribution of waste from the construction industry compared to 2008 (DEFRA, 2011). This increase could be due to increase in output from the construction industry post the recession. The increase also suggests the need to intensify efforts to improve CD&E WM.

Though waste generation from the construction industry as a percentage of total waste has increased, the data from DEFRA (2015) shown in figure 10.1 below suggests that current waste recycling rates for construction and demolition waste is 86.5% for the UK, (89.2% England), which is above the expected levels to be achieved in 2020 as required by the EU WFD. In 2008, 65% of construction and demolition waste was recycled (DEFRA, 2008) which suggests an increase in the recycling rate. Waste recycling rates (shown in figure 10.1) do not include excavation waste which forms a bulk of waste from the construction industry.

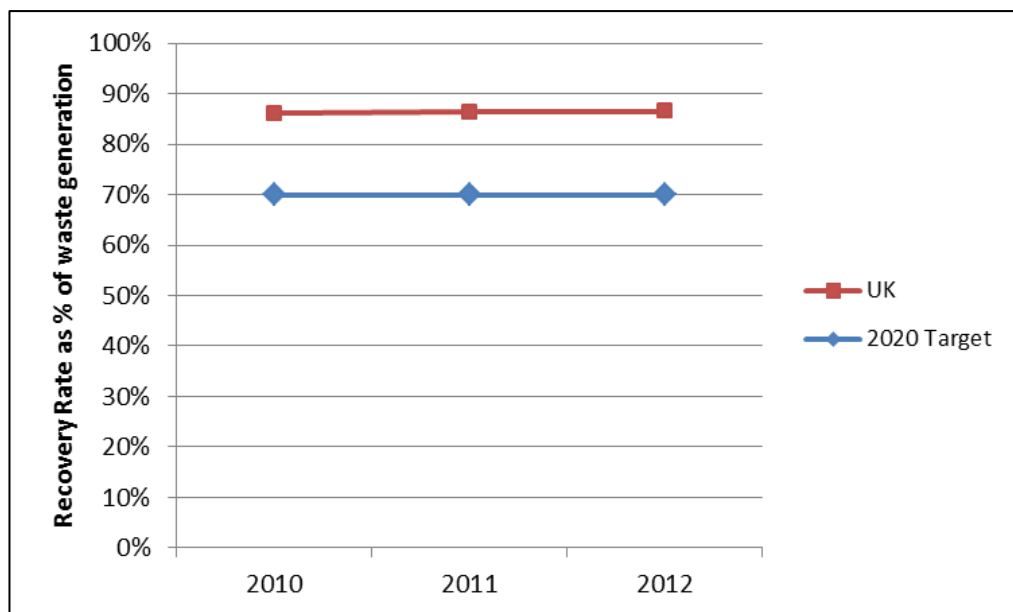


Figure 10. 1: C&D waste recycling rates in UK for 2012

(Source: DEFRA, 2015).

The data available suggests that the construction and demolition waste (excluding excavation waste) recycling rate achieved is goes beyond the expected levels set by both the UK and EU legislative requirements. The results is however likely to be different should excavation waste be included in the computation. Adding excavation waste is likely to drop the recycling rate lower and this means there should be continued effort to improve WM.

Considering the approaches, strategies and practices identified from this research, it can be argued that all construction companies used for this research target achieving diversion rates of more than 90% from landfill (with some companies targeting as high as 100%). Throughout the process, it is very necessary to keep eyes on the most important aspect of the intended outcomes of waste legislation: the extent to which it diverts waste away from landfill; the positive economic influence on projects; and the recovery of waste through recycling and reuse.

## **10.6 CHAPTER SUMMARY**

From the discussion, it can be inferred that there is a general shift towards sustainability in the construction industry. This shift leads to the most influential driver for sustainable CD&E WM, which is company agenda. Company agenda combines all the reasons for which a construction company may sustainably manage waste. The results suggests that the extent to which company agenda drives and influences WM on projects depends to a large extent on the amount of effort put into ensuring company agenda reflects on project sites.

The chapter also presents information on the extent to which CD&E WM activities of construction firms meet the intended outcomes of government WM legislation. The results indicates that currently the industry is achieving recycling rates of 86.5% (for C&D without excavation waste) which is higher than both the EU target of 70% by 2020 and the UK target of 70% in 2012. The next chapter presents a best practice sustainable CD&E WM framework based on best practices drawn all four companies used for this research.

## **CHAPTER ELEVEN**

### **DEVELOPMENT OF BEST PRACTICE CD&E WASTE MANAGEMENT FRAMEWORK AND EVALUATION**

#### **11.1 INTRODUCTION**

From the results of this research and the discussion in chapter ten, it became evident that the development of a framework that draws on the best practices captured from the case studies would make an immense contribution to the achievement of sustainable CD&E WM. This chapter addresses the development of a best practice framework for promoting sustainable management of CD&E WM in construction companies and evaluation of the framework from the perspectives of selected participants. The chapter is laid out as follows: the framework development process is first outlined, followed by a justification of the need for the framework. This is followed by the main components of the framework and recommendations for implementation of the framework. The chapter concludes with the evaluation of the framework.

#### **11.2 SUSTAINABLE CONSTRUCTION, DEMOLITION AND EXCAVATION WASTE MANAGEMENT FRAMEWORK**

WM in the construction industry targets the sustainable use of resources with major emphasis on the prevention of material wastage, pollution prevention, and cost reduction. Current efforts in the construction industry from government, social organisations, and construction companies have all focussed on the need to have measures in place to ensure waste is sustainably managed.

From this perspective, a framework that can put together all the best practices required to enhance the possibility of achieving industrywide sustainable CD&E WM would make an immense contribution towards the zero waste to landfill target within the industry. As argued in Adjei *et al.* (2013), whereas government designs legislation and policy and put demands on industry to achieve sustainable management of waste, the construction industry must commit resources to achieve such goals, whilst academia has the task of having to come up with workable solutions for the industry through their research efforts. This research in fulfilling a



part of that task develops this best practice framework that provides a structured and coherent approach to the management of waste in construction companies. The framework takes into account the two key organisational strata - corporate level and project level, and also takes into consideration three main phases of construction project execution, i.e. design, procurement, and construction. The main objectives of the best practice framework are outlined below:

- To highlight the key features and factors that have the possibility of influencing sustainable WM at the corporate and project levels
- To highlight the practices and strategies that have implications for sustainable management of waste on construction projects
- To provide insights into the various factors that drive and influence sustainable management of CD&E WM
- To guide construction firms in implementing strategies that will result in sustainable management of CD&E waste taking into consideration the factors that influence WM.

### **11.2.1 Overview of the Framework**

The best practice framework for sustainable CD&E WM (Figure 11.1) is built based on the issues identified through the research to have influence on WM. From the results of the research, it was identified that these issues comprise corporate level factors and project level factors. At the project level, three main phases are also considered: design; procurement; and construction. The different phases and the influencing factors as well as required actions are discussed in the sections below.

#### **11.2.1.1 Corporate level WM**

The need for WM within any company begins with a number of drivers that dictate the WM agenda. As gathered from the research, WM within construction firms is influenced to a large extent by the corporate or company level vision which influences the attention given to waste by the construction firms. It was identified that having a system in place (management structure) for the purposes of WM influences what a company can actually achieve. The main components of corporate level WM are:

- Having a structure in place for WM
- Setting a vision

- Defining targets and integrating systems to regularly review against the targets

To implement the targets for WM, there is the need to define the approaches for WM.

### **11.2.1.2 Project level WM**

To be able to implement WM on projects, a number of issues identified from the nine –case study projects which have a bearing on WM have to be considered. For the purposes of WM, this framework breaks WM into three main phases: pre-construction phase; construction phase; and completion. The measures to be put in place as well as the influencing factors for all the phases of the project level are discussed below.

#### ***11.2.1.2.1 Pre-construction stage***

From the data from this research, it was identified that the pre-construction phase of projects presents the best opportunities to make decisions that impact the amounts of waste generated on projects and the management of such waste. The pre-construction phase covers all activities before project teams move to sites and as such includes the design stage, the planning stage, procurement, and the mobilization stage of projects. At the design stage, efforts or actions by both the designer and the clients are the main causes and sources of waste. Being able to design and set in place measures for WM makes immense contributions for WM on the project. For projects with design and build elements, taking steps to design based on resource efficiency and design to reduce waste are the main elements. To be able to do this, there is the need for collaboration between site teams and designers to ensure inputs towards waste prevention can be made by the site teams based on their project level experience. Setting in place a project specific vision for WM as well as targets for WM are both considered vital aspects of pre-construction WM measures. These targets may include the percentage of recycling or reuse required on site, the BREEAM score expected and the general requirement for WM on such projects.

Specific actions at the preconstruction phase include determining the approaches to WM based on company set policies and specific project characteristics. Sustainable management of waste on projects requires the need to have in place a WM plan which takes into consideration the waste streams and quantities expected on projects and the options available for managing all waste streams. A key action as part of the planning is site visits in the case of projects on brown field sites to help inspect and identify existing materials which may

have reusable value on the projects. For projects involving demolition, this is to help identify a demolition strategy. Another influential action is the set-up of a WM system which will help site teams capture waste data and produce progress reports for monitoring of performance.

As gathered from the research, a number of factors drive WM at the project level which must be taken into consideration if sustainable management of waste is to be achieved. These factors can generally be grouped into: economic concerns; company vision or agenda; client demands; the need to maintain company image; changing industry perspectives regarding sustainability, and environmental management; health and safety concerns; environmental concerns; and government legislation. These factors are the main drivers determining why people on projects manage waste. The strongest of the influencing factors are cost, client demands and company vision. For site level staff (both management and operatives), cost is the most important factor considered on site and as such any efforts likely to have a positive influence on reducing cost on the project is welcome. Cost (economic) considerations therefore played a major role in making site teams put in effort towards WM. Beyond cost considerations, the next most important factor influencing site teams to manage waste is the demands of clients for specific actions or targets for WM to be met on projects. Company policy or vision for WM is also a major driver which dictates WM in the absence of client demands or economic benefits. All other driving factors for WM are discussed in section 10.3.2

#### ***11.2.1.2.2 Construction stage of projects***

Considering all the nine projects visited during the research, it was identified that all planning and pre-construction practices and strategies influence the construction stage (where real waste is generated). The construction stage is identified to be the recipient of the choices and decisions of the client and designer which have a very large influence on WM (as discussed in section 9.5). This is because all the '*real work*' takes place during the construction phase. From the analysis of the data collected for this research, it was identified that the main issue for WM at the construction phase is the implication of the strategy put in place for WM. This includes WM practices such as: segregation of waste; reuse of waste; recycling of waste; selective demolition or deconstruction; and supplier take back or buy back schemes (See section 10.3.4).

Other very important practices include training and education of site teams, the institution of a reward and charging system, and the monitoring of WM during the execution of projects. As gathered from the research, education plays a crucial role in ensuring WM on projects is correctly pursued. The essence of education on project sites is to ensure site teams understand what is required of them in terms of WM and are equipped with the necessary skills to meet the demands of WM. The institution of an incentive system for both rewarding best practices and charging for non-compliance is also a key strategy as it has an influence on the attitudes of site teams and sub-contractor personnel who take part in the execution of projects. The incentives (rewards) are required to serve as a boost whereas the charging systems are meant to serve as a deterrent to poor WM practices.

Monitoring the performance of site teams was also identified as the key means by which management teams on projects are able to determine the progress of projects with regards to WM and make the necessary changes to ensure the vision for WM is duly pursued.

A number of factors were identified to influence the extent to which WM is pursued on projects which ultimately affect the achievement of sustainable management of CD&E waste (See 10.3.6). These influencing factors are divided into two main groups: factors within the control of site teams; and factors outside the control of site teams.

#### 11.2.1.2.2.1 Influences within the control of site teams

Factor within the control of site teams include approaches of senior management towards WM, planning at the initial stage of projects, works programme, level of understanding of WM, ability to identify waste reuse potential of materials, attitudes of site teams towards WM, relationships between site teams and suppliers, charges for poor performance, and rewards for best performance. As discussed in section 10.3.6, on all the 9 project sites visited for this research, a key influence within the control of site teams that influenced the outcomes of WM efforts was the approaches of senior management towards WM. According to some sub-contractor staff interviewed on the projects, if the main contractor is very seriously interested in WM, it affects the whole of the site and the level of importance everybody on site attaches to WM issues.

#### 11.2.1.2.2.2 Influences outside the control of site teams

Beyond the factors listed above, there were a number of factors that influence the outcome of WM but fall outside the control of site or project teams. These factors were identified to either be within the control of designers, clients or the corporate level of construction companies and included: complexities of design forms or shapes; availability of space on site; type of construction technology; size of project; expectations of repeat jobs (for sub-contractors); time allocation on projects; number of suppliers on projects; and the relationship between site and design teams. Though these influencing factors were identified to be outside the control of the site teams, they have consequences on the outcomes of waste management efforts on project sites and present opportunities for the main contractor companies or clients for that matter to influence their choices or strategies which ultimately will affect the results achieved from waste management.

#### *11.2.1.2.3 Project Completion stage*

At the completion stage of projects, it was identified from most of the projects visited that there is hardly any push for the review of waste management. Being able to review performance of projects in terms of waste management can serve as a means to get feedback to the company in terms of areas company strategy or policy that may require attention. A major factor influencing the project completion stage is the general lack of personnel on site who were involved in the project to help review performance. Monitoring during the construction stage served as inputs for the review at the end of projects.

### **11.2.2 The Need for a Coherent Approach to Waste Management**

From the factors and issues discussed above, it can be identified sustainable management of waste can best be achieved when there is a coherent approach to waste management. Results presented on corporate level WM suggest that sustainable WM is achievable when particular attention is given to WM at corporate level. This requires conscious efforts to establish a vision for waste management and put in place a strategy to ensure this vision is operationalised. Corporate level waste management has three main components as shown in section 11.2.1.1. For corporate level WM to influence WM on construction projects, there is also the need to put measures in place at all the phases of the project level: pre-construction; construction; and post construction (See section 11.2.1.2).

Putting together insights from the research, the best practices identified from the corporate as well as projects levels are amalgamated to form a best practice model for sustainable waste management (See figure 11.1) which is intended to help the construction industry sustainably manage waste by having a holistic approach towards waste management.

## BEST PRACTICE CD&E WM FRAMEWORK

### BEST PRACTICE SUSTAINABLE CONSTRUCTION, DEMOLITION AND EXCAVATION (CD&E) WASTE MANAGEMENT FRAMEWORK

#### LEGEND

- Flow of action
- Influence of Corporate Level on Project Level
- Feedback from project level to Corporate Level
- Collaborative relationship
- Influence

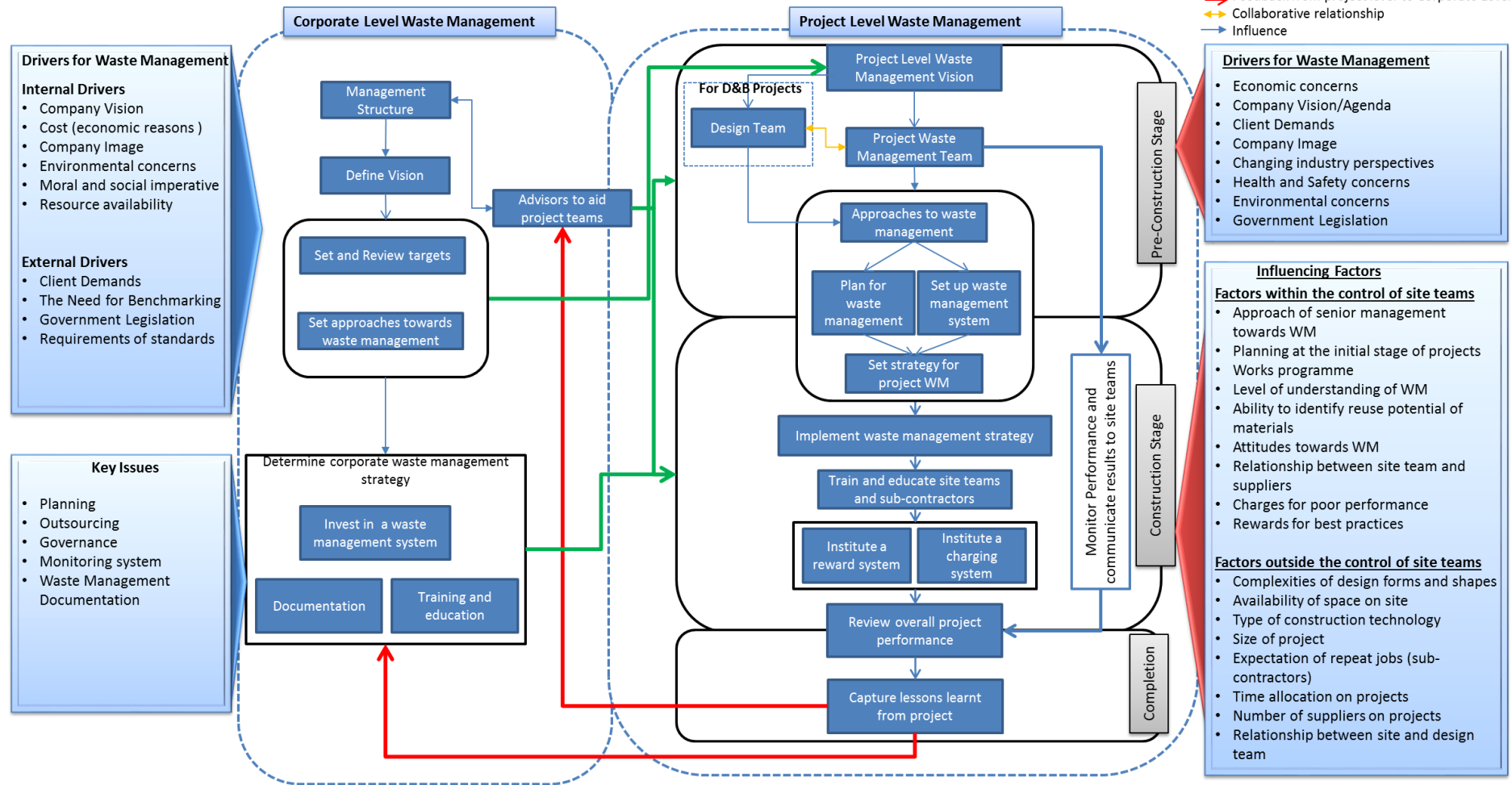


Figure 11. 1: Best Practice Framework for sustainable CD&E WM

### 11.3 IMPLICATIONS FOR PRACTICE

The best practice framework for the management of CD&E WM has significant implications for the pursuit of sustainable CD&E WM. For the framework to achieve the required aims, an implementation guide has been designed which will help corporate level and project level teams make the most of the framework.

#### 11.3.1 Guide for implementing the best practice framework

Implementing the best practice framework requires efforts from both the corporate and project level of companies to help make the necessary adjustments based on the issues prevailing at the corporate and project levels. As identified throughout the research, sustainable CD&W WM can only be achieved when there are systems in place set by the corporate level of construction companies and these systems are adhered to at the project level. The ability to achieve sustainable CD&E WM is therefore dependent on the quality of the systems or measures in place at the corporate level and the extent to which this is followed on projects.

A summary of the guide for implementing this best practice framework is given in table 11.1



Table 11. 1: Framework implementation guide

	Required Actions	Implementation notes
Corporate Level		
1	Set up a CD&E WM structure	Achieving sustainable WM begins with having a structure in place with responsibility to oversee WM functions at the corporate level.
2	Define WM vision	A clear vision for WM should be defined and measures put in place to pursue the vision. WM vision is determined by drivers influencing WM.
3	Set targets for WM	Corporate level targets for WM must be set and should be reviewed at regular intervals to reflect corporate vision
4	Determine approaches for achieving targets	Approaches must be defined for tackling WM issues and a workable strategy for achieving this on projects put in place. As part of this, strategies to plan, monitor and govern WM should be determined. Documentation to aid WM must also be prepared.
5	Set up a strategy for achieving targets on project	
Project Level		
Pre-construction phase		
6	Define project level WM vision	Project level vision for WM must be defined. Measures to ensure project level vision reflect corporate vision should be put in place
7	Put together a team for WM	A team for overseeing WM must be set up at a very early stage of the project.
8	Involve WM team at the design stage	Ensure site management team is involved early on at the design stage to enable them make inputs for reducing waste by design
9	Plan for WM	Determine the approach to WM on the project and put in place a plan for managing waste before construction phase begins. This includes setting up a WM system and strategies for managing waste on the project.
Construction phase		
10	Set up and implement a WM strategy	Implement the strategy for WM on the project and train site teams to ensure they understand the demands of WM for the project. Factors

## BEST PRACTICE CD&E WM FRAMEWORK

11	Train and educate site teams on WM	influencing WM at the project level must be taken into consideration and used to advantage.
12	Institute charging and reward systems for WM	Institute a reward and charging scheme on site to award best performing teams while charging for non-compliance with company WM policy.
13	Monitor Performance	WM performance should be monitored to measure progress and identify issues where possible. Performance should be reported to site teams so they have a better understanding of the consequence of their actions. Advisors from the corporate level can serve as auditors for WM
14	Inform site team of their performance	
Project completion phase		
16	Review overall project WM performance	Review WM performance at the end of projects to help identify best practices as well as issues affecting waste on the project. Capture lessons learnt and feed that back into company level approaches and strategy.
17	Capture lessons learnt from project	

As shown in Table 11.1, achieving sustainable CD&E WM begins by first having a management structure in place at the corporate level of the company to have responsibility to WM. This could be a simple structure and there is no set number of personnel required to establish the structure. The most important aspect is having a management structure in place with the responsibility of managing waste and having oversight responsibility for WM. This structure is usually likely to be within the environmental or sustainability department of the company. The first action of the management is to be able to define a vision for WM within the company. Defining a vision for WM helps the company to work towards a target and as such directs all WM actions and decisions.

A clear vision means the company has a specific aim for managing their waste and this is to a large extent determined by the drivers for managing waste where drivers are the reasons why the company would want to achieve sustainable WM. As shown in the framework, the factors likely to drive construction companies to manage waste are: economic concerns; company image; environmental concerns; moral and social imperatives; client demands; the need for benchmarking; government legislation; and

requirements of standards. All or any combinations of these drivers will influence the vision for WM in the company.

The next step after defining the vision for WM is to set specific targets for what level of WM is to be achieved by the company. Targets can be set on yearly basis or as required by the company. These targets should periodically be reviewed to ensure the company is moving in the right direction with regards to WM. Review can be based on the performance of the company from time to time in relation to achieving the set targets. Beyond setting the targets for WM within construction companies, the next step for the management team in the company in charge of waste is to be able to determine the approach the company will take in meeting the set targets or objectives. The approaches should then be translated into workable strategies which can help the company achieve the targets. Strategies as shown in the framework should cover areas such as: planning for WM; whether or not to outsource some functions; the management structure needed to implement the strategy; a monitoring mechanism or system to ensure targets are being met; training and education on WM; and documentation in place for guiding WM.

Once the corporate level WM structure, vision, targets, and strategies have been established, there should be measures to implement sustainable WM on projects. The best practice framework for WM considers WM at two main stages of projects: the pre-construction phase; and the construction phase.

At the pre-construction phase of projects, there should be a project specific vision for WM. Drivers responsible for determining the targets and vision for WM on the project should be the company level vision and strategy. Other project level drivers include: health and safety concerns; and ‘changing’ industry perspectives on waste. Though all construction projects differ and may not share the same vision, project level vision should reflect corporate level vision as much as possible. Once the vision is set, the next step is to have a team in place for managing waste on the project. The size of the team is dependent to a large extent on the size of the project but usually should have at least one person to have oversight responsibility for waste on the project. The team in place should be made up of people who understand WM and the company’s vision regarding WM.

Due to their role on the project and the influence they are likely to have on WM, it is important to involve the project level WM team (and in some cases the corporate level WM team) as early as possible on the project. For design and build (D&B) projects, this

means involving the teams in charge of WM at the design stage to help make inputs regarding WM. As part of the pre-construction phase WM, a plan for managing waste on the project should be made. Planning includes determining the waste streams and quantities likely to occur on the project and devising a strategy for managing them. In some instances, planning for WM will include visiting the project site to determine avenues for waste reuse and management and layout of site for providing skips. This also includes setting up a system to help in managing waste on the projects (usually the environmental management system or integrated management system used by the company).

After defining and setting up strategies for WM on the project, the next stage is to implement WM strategies on the project. As part of the WM strategies on the project, there should be training and education of site level teams including sub-contractors on the vision for WM on the project and the strategies developed to help achieve the vision. It is also a good practice to institute a reward and charging scheme as part of the approach on site to ensure site teams comply with requirements for WM.

Throughout the construction process, WM performance should be measured to help determine whether or not the strategy is working. Two sets of factors are identified to influence WM performance: factors within the control of site teams; and factors outside the control of site teams. Factors within the control of site teams identified to influence the performance of projects regarding WM are: approaches of senior management towards waste; amount of planning at the initial stage of projects; works programme; level of WM knowledge; ability to identify avenues for WM; attitudes towards WM; relationships between site teams and suppliers; charges for poor WM performance; and rewards for best practice WM. Factors outside the control of site teams include: complexities of design forms; availability of site space; types of construction technologies; size of projects; expectations of repeat jobs for sub-contractors; time allocation on projects; number of suppliers on projects; and the relationship between site teams and design teams. Giving attention to these factors and taking advantage of them can positively influence site teams leading to improved WM.

At the end of projects, the framework suggests that there should be a final review of WM performance to have a general overview of how the project performed. This also helps to measure the impact of interventions that occurred during the project execution phase.

Lessons learnt from this review and throughout the project should then be captured and fed back into the corporate strategy so the necessary adjustments can be made.

### **11.3.2 Recommendations based on the framework**

The framework is designed to be used by construction companies as part of efforts to sustainably manage the CD&E waste on their projects. For the framework to have its intended impact, the following recommendations are made.

#### **11.3.2.1 General recommendations**

Achieving sustainable WM comes with some resource demands and as such requires commitment on the part of the construction company. It takes a proactive organisation to be able to pursue the subject of sustainability and as such sustainable WM requires companies to be willing to make the necessary adjustments and to be willing to adopt new ways of doing things. Achieving sustainable WM requires the construction company to consider WM a key function within their setup and a major aspect of their environmental management or sustainability agenda. This will make it possible to make the company commit resources towards WM.

## **11.4 FRAMEWORK EVALUATION**

The proposed framework and its recommendations were evaluated to ensure the framework made the maximum contribution towards sustainable CD&E WM. This section discusses the rationale for the evaluation and presents results from the evaluation process.

### **11.4.1 Rationale for Framework Evaluation**

The proposed best practice framework for sustainable CD&E WM was designed as a result of consolidating all the outcomes and more especially, best practices from the research. The rationale for evaluating the framework is to meet the following objectives:

1. To assess the adequacy and completeness of the best practice framework in leading to sustainable CD&E WM
2. To assess the clarity of the framework and ease of use should any construction organisation decide to adopt the framework for managing their CD&E waste;

3. To confirm from the participants if the key features that emerged as leading to sustainable CD&E WM and their influences were reflective of what happens in practice;
4. To confirm from the participants if the factors identified to influence the extent to which sustainable CD&E WM can be achieved were reflective of what happens in reality;
5. To evaluate the feasibility of the proposed recommendations for achieving sustainable CD&E WM and how companies will adopt this in their organisations.

The same companies used for collecting data during the research were the companies used in evaluating the outcome of the framework. Based on the objectives of the evaluation, each participating company was sent a summary report of their company's WM including specific recommendations to their company. This was accompanied by the best practice framework and a short questionnaire directed at meeting the objectives (See Appendix 11). For some of the companies, there was a PowerPoint presentation whereas for others, outcomes of the research together with the framework and the questions were discussed without presentations.

#### **11.4.2 Background of Organisations and Participants**

Three of the four companies used for the main research, Companies A, B, and D, were involved in the framework evaluation process. In all these companies, managers in charge of waste and environmental issues were contacted to partake in the research. Background information on these companies is presented in Section 6.5.2.1

For company A, two key personnel were involved in the evaluation process: the sustainability manager at group level within the company; and the sustainability manager for construction. For Company B, three key personnel were involved in the evaluation process: the senior environmental advisor who is in charge of all environmental issues relating to the construction business of the company; and two environmental advisors who help project teams to plan and manage waste. For company C, Environmental manager who is in charge of ensuring targets for waste and environmental issues are met on projects was involved in the evaluation process.

Summary of the background of the participants is presented in table 11.2 below.

Table 11. 2 Background of participants for Evaluation

<b>Position</b>	<b>Organisation</b>	<b>Gender</b>	<b>Years of Experience</b>
<b>Sustainability Manager (Group Level)</b>	Company A	Female	10-15 years
<b>Sustainability Manager</b>	Company A	Male	Over 20 years
<b>Senior Environmental Advisor</b>	Company B	Male	Under 5 years
<b>Environmental Advisor (Midlands)</b>	Company B	Female	Under 5 years
<b>Environmental Advisor</b>	Company B	Male	15-20 years
<b>Environmental Manager</b>	Company D	Female	15-20 years

### 11.4.3 Discussion of Evaluation Feedback

Feedback from the participants from the evaluation process (6 individuals in number) is discussed in this section under four main themes: usefulness of the framework; feasibility of the recommendations; adequacy and completeness of the framework; and suggestions for improvement of the framework.

#### 11.4.3.1 Usefulness of the Framework

All six participants were of the view that the framework presents a very useful tool for planning waste management within construction companies. In responding to the question on ‘whether or not the framework provided a structured, well-informed and holistic approach to implement sustainable CD&E WM, all participants answered yes and suggested it presents a good basis for planning for waste management. The Environmental

Manager for Company D suggested she would adopt the framework when she made this remark:

*“Yes I would consider using it as a foundation to replace the old SWMP framework”*

Participants from company A who have a guide for waste management on their projects suggested they will fuse portions of the framework into their strategy for waste management. The senior environmental advisor for company B suggested the framework will help the company in planning waste management at the project level as they already have a similar strategy for the corporate level. According to the senior environmental advisor:

*“I find the final part of the framework very useful as a review at the end of projects to capture lessons that will feed into the corporate strategy will help in improving the corporate level strategy”*

All participants were happy with the framework and suggested it will make a big difference to their waste management efforts.

#### **11.4.3.2 Feasibility of the Recommendations**

On the feasibility of the recommendations made by the framework, the general view of all participants was that the framework has very good recommendations that can translate into improved waste management on projects. The senior environmental advisor for Company B suggested that some of the recommendations made by the framework are issues he has been thinking about. In his own words:

*“I have been thinking of ways we can use incentives to actually improve the attitudes of people on site, I think this is a recommendation I will consider implementing on site”*

After this comment, he asked the environmental managers how this can be implemented on their sites and they suggested possibly giving breakfast coupons as incentives will make a difference. The senior environmental advisor suggested he will bring up the report and the framework at the next environmental team meeting so other members like the environmental director can decide on what to do with the insight.

Participants were asked to indicate any barriers that may hinder the implementation, the Environmental Manager for Company D made the following suggestion:



*“Influence of specific systems which may be applied such as the BREEAM resource management plan and SMARTwaste”*

A general suggestion was that on most projects, the construction companies were not involved at the design stage and as such the recommendation to involve project teams at the design stage was not feasible.

#### **11.4.3.3 Adequacy and Completeness of the Framework**

All six participants were of the view that the framework was very adequate as all sections of the project cycle have been included. All participants suggested the drivers for waste management at the corporate and project level captured all the major reasons why they manage waste and that suggested a lot of work had been done to fully understand their processes. The sustainability manager for construction businesses in Company A found the insight from the influences on the achievement of sustainable waste management at the project level very interesting. His exact comments were:

*“Thank you very much for this framework, I thought we had everything covered but from this I can tell there are certain factors we have not been looking at in our company. I think this framework makes a lot of sense, especially the influences on the outcome of waste management efforts”*

The environmental advisors for Company B made similar comments which suggested the adequacy of the framework. The Environmental Advisor for the Midlands business of the company made the following specific comment:

*“The framework is very interesting and to me very adequate. I think the suggestion that assurance of repeat jobs influences sub-contractors is very true. Once sub-contractors are assured that doing things in a particular way will help them win the next contract from you, they willingly do it”*

She went further to explain that from the few years she has been dealing with site teams as an environmental advisor, she has come to realise that some of the factors mentioned in the framework can easily lead to behavioural change. She cited her most recent project as an example where the approach of the project manager towards waste had a major influence on the operatives.

#### 11.4.3.4 Suggestions for Improvement of the Framework

Participants were asked to suggest any improvements to the framework to enhance its ability to have the most impact on achieving sustainable WM. The views of the participants generally suggested that the framework generally captures the most important aspect of WM have been covered by the framework. A few suggestions were however made. The Environmental Manager for Company D had this to say:

*“To me the framework is complete although it is helpful to have a system which rates the subcontractors specifically on waste issues and helps maintain their duty of care compliance for carrying waste and supplying recycling rates etc. which can be used for the selection process on future projects”*

The Senior Environmental Advisor for Company B suggested that though the framework is very useful and covers all aspects needed, there appears to be too many sections and it may be difficult for personnel who do not have adequate knowledge of waste management at the project level to implement it.

In summary, the evaluation process proved that the framework developed for sustainable CD&E WM is very useful and will serve as an appropriate roadmap for construction companies to implement sustainable CD&E waste management. Positive feedbacks were given by the participants on all the recommendations put forward based on the framework. It was identified from the evaluation that having knowledge of the influences on the outcome of waste management efforts was very important to construction companies as they could manage these factors to their advantage.

### 11.5 CHAPTER SUMMARY

This chapter has discussed the development of a best practice framework for sustainable WM which is the main contribution from this research. The chapter has also presented a guide to help construction companies implement the framework. Recommendations for improved waste management in the construction industry have also been made as part of the framework. The adequacy and usefulness of the best practice framework has also been determined through the evaluation process as discussed in this chapter. The next chapter concludes the research by discussing how all the objectives set out by this research have been achieved.

## CHAPTER ELEVEN

### CONCLUSIONS AND RECOMMENDATIONS

#### 12.1 INTRODUCTION

The research has investigated waste management practices within the UK construction industry with emphasis on the extent to which they meet the intended outcomes of government waste management legislation. The research has led to a number of findings which have been consolidated by the development of a best practice framework for the sustainable management of CD&E waste. This chapter presents a summary of the entire research and then presents the main conclusions, contribution to knowledge, and the limitations of the research. These are followed by some consideration of potential industrial implications of the research findings particularly in relation to achieving sustainable CD&E waste management and recommendations for future research.

#### 12.2 ACHIEVEMENT OF RESEARCH OBJECTIVES

The objectives for this research are presented in section 1.3 of Chapter One. A total of six research objectives were framed to help achieve the aim of the study. All six objectives have been achieved through the application of a rigorous research design presented in Chapters Six and seven. Table 12.1 summarises the methods applied in achieving each research objective and the chapters containing the evidence of such achievements.

Table 12. 1: Methods used to achieve research objectives

Research Aim	Research Objective	Method of achievement	Chapter Presented
To investigate current practices of CD&E WM in relation to the extent to which they meet the intended outcomes of legislation and relevant policy documents and to suggest an agenda for improvement action	1. Review environmental and sustainability concerns influencing the development of WM legislation and policy.	Reviewed extant literature on environmental management, waste, and sustainable development	Chapter Two Three
	2. Identification of relevant legislation and policy statements applicable to CD&E WM in the UK and their intended outcomes.	Reviewed extant literature on the legal framework for waste management in the UK	Chapter Three
	3. Establishment of the key elements of current CD&E WM practices in the UK and development of measures of CD&E WM outcomes.	Reviewed extant literature on construction, demolition and excavation waste management	Chapter Four
	4. Production of a conceptual/theoretical framework for assessing extent to which the intended outcomes of the legislative or policy interventions are being met by current practices.	Synthesised outcomes of the review to develop a conceptual framework for assessing the extent to which CD&E WM led to the achievement of government intervention	Chapter Five
	5. collection of relevant data on WM to determine the policies of firms towards waste management, how they translate into practice to meet the intended outcomes of legislation,	Undertook exploratory interviews, documentary analysis, and passive observations using four case study companies and 9 live projects to understand the WM process from corporate to project level. Analysed all data	Chapter Six, Seven, Eight and Nine

	and identify gaps in performance and management practice	received using QSR NVivo 9 data analyses software. This helped with the development of themes and matching of empirical patterns to research questions.	
	6. Identification of appropriate remedial action for deficient CD&E WM practices and development of strategies for improvement action.	Based on outcome of research and review of literature, actions required for achieving sustainable WM were identified which was then used in the development of a best practice framework for sustainable development. The framework was evaluated through semi-structured interviews and presentations to obtain feedback from environmental managers, sustainability managers, and environmental advisors.	Chapter Ten, Eleven, and Twelve

## 12.3 CONCLUSIONS OF THE RESEARCH

The following conclusions are made in relation to the research questions posed:

- ❖ The main obligations of current WM legislation for construction companies is the need to ensure waste is sustainably managed on site and only transferred to licenced personnel. For the purposes of meeting requirements of waste legislation, construction companies ensure only legally compliant suppliers, sub-contractors and registered waste carriers are dealt with.
- ❖ To sustainably manage CD&E waste, construction companies adopt WM or environmental policies which indicate their commitments to WM and influences their WM efforts. WM or environmental policies of construction firms state their targets for waste management and give an indication for how these targets are to be achieved on projects.
- ❖ Resources employed to manage waste take the form of company personnel, and environmental management or integrated management systems, and material resources. This research concludes that, regardless of the commitment a company

may have towards waste management, the availability of resources influence how waste gets managed on projects.

- ❖ Factors dictating WM in the construction industry are: economic considerations; company sustainability agenda; client demands; company image; moral and social imperatives; benchmarking; concerns for the environment; government legislation; and requirements of standards. The extent of these drivers in dictating WM however differs from one company to the other.
- ❖ The main driver for construction firms to manage waste is the economic incentives associated with managing waste on projects. The most influential driver for achieving sustainable WM is company sustainability or environmental agenda which integrates all drivers for WM and cause firms to pursue WM for sustainability or environmental reasons.
- ❖ Major players with influence on CD&E WM are: clients; designers; contractors; suppliers; and manufacturers. The decisions of all these actors influence the amount of waste generated on projects. The client has influence on WM as their
- ❖ Current government WM legislation does not have full impact on WM, especially at the project level and this is due to the enforcement approach adopted. There is the need for a better approach to ensure government legislation yields the required level of impact on WM. Approaches that encourage and support companies to meet the demands of legislation have a better impact in ensuring the demands of legislation is met.
- ❖ At the project level, practices such as the use of cutting sheds, segregation at source, reuse of offcuts, and training of site teams are identified to contribute towards waste reduction.
- ❖ The extent to which sustainable WM is achieved on depends to a large degree on factors such as: the ability to make to make corporate agenda influence project level WM; availability of resources; attitudes of site teams towards WM; attitudes of senior management on site; the ability to identify avenues for WM; the type of construction technology used on-site; standardization of components; complexity of design forms; relationship with manufacturers; programming of works; size of project; understanding of the demands of WM; availability of space on-site; early planning of the project; the level of WM education on projects; and the stage of projects.

- ❖ Sustainable WM can be achieved when a conscious effort is made at the corporate level and resources are committed to ensure the efforts drive WM strategy on projects.
- ❖ Having end of project performance reviews with emphasis on WM will help firms to capture lessons learnt which will influence WM strategy.

## 12.4 RESEARCH CONTRIBUTION

The contribution made by this research is presented in three main sections: theoretical contributions; methodological contributions; and practical contributions. These are presented in sections 12.4.1, 12.4.2, and 12.4.3 respectively.

### 12.4.1 Theoretical Contributions

Though the subject of WM practice and legislation have been widely studied, research investigating the extent to which practices of construction firms meet the intended outcomes of WM legislation is non-existent in the literature (Yuan and Shen, 2011). Studies involving waste or environmental management and legislation have always concentrated on the whether or not firms complied with government legislation and the means to improve compliance (See Sáez *et al.*, 2011; Wang *et al.*, 2010; Osmani *et al.*, 2008; Begum *et al.*, 2007; Davenport, 2003; Seydel *et al.*, 2002;). As admitted in Mitchell (1996), compliance in itself does not necessarily denote that the goals of legislation are being met. This makes the need to investigate the extent to which compliance efforts meet the intended outcomes of government legislation very important.

To contribute to the knowledge gap in the literature, the research findings provide empirical accounts of the extent to which the approaches to WM and the practices of construction firms contribute towards meeting the intended outcomes of government legislation. As identified in Section 3.4.3, government legislation on WM target sustainable WM with the overall aim of reducing resource consumption, pollution and the increasing cost of projects due to excess waste generation. Achieving the intended outcomes of WM legislation requires waste management practices to result in waste reduction, pollution prevention, reduction in the use of natural resources, and reduction in the negative effect of waste generation on project cost. Evidence from this research

suggests that achieving sustainable WM requires a holistic effort which begins from corporate level structures to integrate WM into mainstream project level practices.

Existing literature suggests that WM legislation is the most critical success factor for ensuring waste is sustainably managed and as such effort has been put into ensuring compliance with government legislation. This research suggests that legislation serves as a driver through a secondary means and as such rather than concentrate solely on making construction firms comply with legislation, efforts should be made to include especially clients who have a very key influence in driving waste management agenda. Factors such as: economic considerations; client demands; company agenda; company image; industrial benchmarking; social and moral implications; environmental concerns and the requirements of standards have been identified from this research as very influential in driving the WM agenda of construction companies. Though the factors are not new to the WM literature (See Yuan and Shen, 2011; Hao *et al.*, 2010; Osmani *et al.*, 2010; Begum *et al.*, 2006; Thomson *et al.*, 2005), this research has been able to investigate the interrelations between the factors and the extent to which each factor drives sustainable WM. This insight will help in guiding future directions on WM.

A common trend in previous studies on sustainable CD&E WM is the concentration on different areas of the WM process. Commonly studied areas are attitudes of workers (Manewa *et al.*, 2007; Theo and Loosemore, 2001); role of management (Urio and Brent); practices to reduce waste; critical success factors (Osmani *et al.*, 2010); outcomes of different technologies; design influences (Urio and Brent, 2006); WM legislation (Osmani *et al.*, 2010); and recycling processes (Townsend, *et al.*, 2007). No study has covered the overall process involving construction firms which is able to print a holistic picture of WM in construction firms which can help make the most contribution to sustainable CD&E WM. This study contributes to this gap by investigating WM in construction firms from both corporate and project levels and including design, procurement, construction and post construction phases of projects.

Based on the holistic nature of this research, the outcomes have been integrated into the development of a best practice framework which assembles key features from the best strategies and practices identified from all companies. This contributes to the knowledge on WM by providing a structured and coherent framework for achieving sustainable CD&E WM and provides a guide for implementing the framework.



### 12.4.2 Methodological contributions

From the summary of CD&E WM studies presented in table 4.1 (see section 4.4) studies on waste management behaviour and practices of construction firms largely rely on the use of measurement scales in the form of questionnaires to statistically measure actions and influencing factors (See Yuan and Shen, 2011; Zhao *et al.*, 2010; Tam, 2008; Theo and Loosemore, 2001). Other studies on the impact of construction activities on the environment and management activity on the outcomes of waste management have relied on the logistics regression and simulation techniques to model influences (Knoeri *et al.*, 2011; Begum *et al.*, 2009). These methods however, had difficulty in providing a full picture of the WM process as efforts were project based.

The use of multiple case studies in this research to conduct a two tier study for corporate and project levels made it possible to have a holistic view of the waste management process from both perspectives. This revealed that efforts towards waste management are neither corporate level only nor project level only based. This approach presents a methodological contribution that enables waste management to be investigated at both project and corporate levels within construction industries with the ability to collect integrated views from corporate level, project level, and sub-contractor personnel who have influences on the outcome of WM.

### 12.4.3 Practical contributions

The best practice sustainable CD&E WM framework developed from this research provides a practical guide for construction firms (especially large construction firms) in pursuing sustainable WM. This single framework provides a better understanding of the requirements for sustainable WM from both the corporate and project levels of construction firms making it a holistic guide for WM. The best practice framework could serve the following purposes:

- a roadmap for large construction firms in designing and implementing waste management strategy within their companies;
- a basis for directing WM training and education to inculcate factors that influence the outcome of waste management efforts; and
- an alternative or a supporting document for WM planning on projects.

## 12.5 PRACTICAL IMPLICATIONS

The findings from this research present practical implications for construction firms, WM legislators, clients and society. Some of these practical implications have already been discussed in Section 10.4. Considering the negative impact of high rates of CD&E waste on the environment, on resources, and the profitability of construction firms, efforts must be in place to ensure construction companies make the best of their waste management efforts. Due to the resource demands involved in the management of waste, it is very important for construction companies to ensure every input into the WM process contribute positively to the goals of sustainable WM.

The first implication of the results is that construction companies need to have a clear vision for WM to be able to drive WM on their projects. WM vision is influenced by a number drivers that determine why a company wants to manage waste and these are usually: the need to cut down cost; company vision; to meet the demands of clients; concerns for the environment; company image; the need for benchmarking; requirements of government legislation; moral and social imperatives to manage waste; and the requirements of standards construction firms may subscribe to. To be able to manage waste for all the reasons listed requires construction firms to have in place a manage structure that at the corporate level who will give special attention to WM. The team in place should then set the corporate WM agenda and this includes targets for WM which will have to be renewed periodically. To be able to convert the targets and vision into WM practices on projects, there is the need to develop approaches to manage waste by targeting all the three phases of projects: design; procurement; and construction. Approaches should then be developed into management strategies which should include strategies to plan for WM, train staff; system for capturing WM data and monitoring performance; strategies to outsource WM duties when necessary; and documentations to aid the WM process.

A practical implication of this study is that there is the need to make conscious efforts to translate corporate level vision, approaches, and strategies into project level activities as waste generation and management occurs on project sites.

For projects to achieve the targets set for WM at the corporate level, the results suggest there should be corporate level staff to act as resource persons and auditors for WM helping site teams to manage waste. This there is also the need to involve site teams early in the design stage of projects for design and build projects as they can make practical

contributions towards waste reduction. There should also be a team on projects in charge of WM with responsibility to plan, design project level WM strategy, implement, and monitor the waste management process on site.

The success of project level WM strategies and practices achieving sustainable outcomes depends on a number of factors that can promote or inhibit the achievement WM. These factors are: availability of resources; attitudes of site teams; the ability to identify avenues for WM; the type of construction technology used on-site; standardization of components; complexity of design forms; relationship with manufacturers; programming of works; size of project; attitudes of project staff towards waste; understanding of the demands of WM; availability of space on-site; early planning of the project; and the stage of projects. Construction firms should put in place actions to convert these factors into enablers.

## **12.6 APPLICABILITY OF THE BEST PRACTICE FRAMEWORK FOR SUSTAINABLE WASTE MANAGEMENT ON REAL PROJECTS**

The framework developed in this research can be applied both at the corporate and project level in construction firms by serving as an aid for planning, monitoring, managing and reviewing activities to achieve sustainable WM. At the corporate level, the framework makes recommendations for defining a waste management vision and putting in place a structure for achieving the vision by setting specific targets which could be reviewed periodically. This framework can help companies plan for corporate level WM strategies by developing a means to achieve the corporate WM vision. At the project level the framework also makes recommendations for the site teams to setup and implement a strategy that can help achieve the corporate vision. Factors likely to affect the outcome of WM on projects have also been provided so project teams can pay attention to such factors to ensure they achieve the best outcome from their waste management efforts. At the end of projects, the framework also makes recommendations for project teams to conduct a post project review so lessons can be captured for future projects.

A detailed implementation guide for applying the framework is provided in section 11.3.1 of this document. A summary is also provided in Table 11.1 on page 315.

### **12.6.1 Transferability of the framework for use on other projects**

The framework developed in Chapter 11 (Figure 11.1) can be used on other projects by serving as a guide or tool to aid in the planning and implementation of waste management strategies in construction firms. Due to the nature of the framework and the demands, it can best be used by medium and large firms who have the resources to pursue sustainable waste management. For such companies, the framework can serve as an integral part of the documents at the planning stage of projects. During construction, the framework can also serve as a guide to know which areas to focus more attention on. Though this framework is expected to contribute to sustainable WM in all construction companies, it is unlikely to be very influential in very small construction companies who may not have the resources in terms of personnel and systems to plan and manage waste as required by the framework. Even in such instances, the framework can give such small firms a fair idea of what they may do to manage waste.

## **12.7 LIMITATIONS OF THE STUDY**

Managing waste in the construction industry requires efforts from contractors, clients, manufacturers, suppliers, and legislators (enforcement agencies) as their decisions in one way or the other impacts the outcome of waste management. This research was however restricted to construction firms with no inputs from clients, manufacturers, suppliers, and legislators. It would have been important to explore the efforts of all other players and the extent to which they influence on the outcomes of WM in the construction industry. This was not possible due to the limited time scale for this research.

Another limitation of this research is the inability to empirically generalise the results of this research throughout the wider UK as only four large construction organisations in England were used. The type of construction organisations used for this research limits the application of findings to cases which bear similarities to those reported in this study.

Due to time and resource constraints, it was impossible to determine how widespread the results of this study are in the industry through the use of questionnaire survey that could reach a wider population of construction firms. This contributes to the limitation of empirical generalisation of this research.

## 12.7 RECOMMENDATIONS FOR FUTURE RESEARCH

The limitations of this research outlined in the section 12.6 above provide the opportunity for future research. The directions of recommended future research include:

- I. Considering majority of the construction firms in the UK are medium sized, who may not have the luxury of resources and personnel like the large firms used for this research, there is scope to explore waste management practices of small and medium size firms who are at the mid to lower end of the construction league tables to determine how their activities contribute to meeting the intended outcomes of government legislation.
- II. There is also scope to conduct research that will apply the best practice CD&E WM framework over a period of time in a construction company to determine the extent to which the adoption of the framework will improve the outcomes of their waste management efforts. Such a study will help further fine-tune the framework increasing its contribution to sustainable WM.
- III. An industry wide quantitative study to test the generalizability of the interrelationships between the various elements of the best practice framework as well as the feasibility of the recommendations of the framework can also be undertaken to improve its suitability for promoting sustainable CD&E WM.
- IV. Due to the dynamic nature of the construction industry, further studies into the most appropriate enforcement strategies to ensure government legislation on waste drives the expected outcomes in the industry, involving all the players with impacts on waste management could also help in achieving sustainable CD&E WM.

Should all the above studies be undertaken, there is a very high likelihood to provide a more holistic understanding on sustainable CD&E WM which will help reduce the negative impacts of the construction industry on the environment and natural resources, and also on the profitability of construction firms.

## 12.8 REFLEXIVITY

The art and science of researching is influenced to a large extent by the background, and inclination of the researcher, which ultimately affects the areas of research, the angle of investigation, methods for conducting the research and the conclusions drawn from the research. This section presents my reflections on the research journey, by considering my background, beliefs, professional experiences and pre-conceptions that are likely to have influenced the research process.

Interests in this research area started as a result of experiences from my first job role as a project manager and quantity surveyor for a small construction firm in Ghana - West Africa. Having started the job on a part time basis due to my teaching and research assistant commitments at the time, there was always some level of pressure from the Director of the company for me to prepare cutting schedules to ensure waste of reinforcement bars is reduced or prevented where possible. As a project manager for a Japan government funded project in Ghana, tolerance from the project consultants for waste was very low as the contract involved the client paying for materials brought on site for the purposes of the project. This meant high degree of monitoring for waste generation. Unlike the UK, waste management was not well established as a discipline in the Ghanaian construction industry at the time and there was/is no legislation demanding sustainable management on waste from construction projects.

Having initially won a scholarship to investigate the implementation of the Site Waste Management Plans (SWMP 2008) Regulations, this research journey started with a review of legal framework for waste management in the UK construction industry through an exploration of the history of the development of waste management legislation and the concerns leading to the need for waste management. Due to my previous experience in trying to manage waste for the purposes of cost prevention, I came to this research with the notion that cost must be the ultimate aim. Exploration of the Environmental management and development management literatures which formed the basis for pursuing sustainable development gave me the understanding that waste management is not just a means of cutting down cost but there was the need to manage waste for the purpose of the environment and as a means of reducing pollution and the misuse of natural resources.

A year into the research, DEFRA launched a ‘Red tape’ legislative challenge which suggested that SWMP legislation may be scrapped in England. From a meeting with the supervisory team, the research aim was changed to investigating the extent to which waste management practices of construction firms meet the outcomes of WM legislation. This is where methodological decisions became part of the discussion. From initial discussions with the supervisory team, I was advised to spend time in reading research design literature to have a clear understanding of the approaches available for this kind of research. Due to the nature of the study and the level of depth it required, interpretivist approach using qualitative research designs was identified to be the best means for exploring waste management strategies of construction firms and to identify the extent to which they met the intended outcomes of government legislation. A multiple case studies approach was chosen as the most appropriate means to achieve the objectives of the study. I personally found this approach appropriate as there was the need to have a holistic view of the waste management process (from corporate level to project level).

To achieve the best results, companies who had won awards for environmental management and sustainability were chosen as the best source to investigate good waste management practices. Invitation letter were sent to these companies to participate in the research. The plan was to select a maximum of four construction companies from the list who will give positive feedback and interestingly only four companies expressed interest. This gave me confidence that the research will proceed smoothly. Negotiations started with these companies and the level of interest expressed by the companies was overwhelming. The level of interest expressed by the companies made me realise how important the subject area is to the industry and this fuelled the need to ensure the research was not just academic but made contributions to industry. Through the data collection process, different views were expressed by the participants on some practices and their importance. In some instances, interviews were dragged as interviewees were more interested in discussing some issues more pressing to them at the time. Issues such as: near miss accidents; the use of BIM in the industry; and how fast the construction industry was changing sometimes dragged interview times. Efforts were made in all cases to ensure the aim of the interviews was not lost.

In analysing the different types of qualitative data obtained from across the four case studies, there was the need to make interpretations of underlying meanings which was to

some extent influenced by my personal beliefs, values and sense making as a researcher. There were instances where differences in perspectives between interviewees suggested conflicting outcomes, e.g. designers and site teams on the causes of waste on projects. Despite striving to maintain good balance as well as reflect the multiple views from contractors, sub-contractors, designers and operatives, I acknowledge there must be some level of subjectivity within this process. I hope that this reflexion has demonstrated how my background, personal values, and prior knowledge as a researcher may have influenced the research process.

## **12.9 CHAPTER SUMMARY**

In this chapter, the steps taken to achieve the objectives of this research have been discussed including the main conclusions of the study. The practical, methodological and theoretical contributions of this study have all been presented. The chapter has also discussed the implications of the results for achieving sustainable CD&E WM. Limitations of the study and consequently the directions for future research on the subject have also been proposed.

This research has offered empirical evidence of how sustainable CD&E WM can be achieved on construction projects by exploring WM approaches and strategies at both corporate and project levels. As an outcome from this research, a best practice Framework has been produced in chapter 11 which seeks to aid construction companies in their efforts to pursue sustainable CD&E WM.



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## APPENDICES

### APPENDIX 1

#### LIST OF RESEARCH PUBLICATIONS FROM THE RESEARCH CONFERENCE PUBLICATIONS

- Adjei, S, Ankrah, N, Ndekugri, I and Searle, D (2015) Investigating the extent to which waste management legislation affects waste management practices within the UK construction industry *In: Raidén, A B and Aboagye-Nimo, E (Eds) Procs 31st Annual ARCOM Conference, 7-9 September 2015, Lincoln, UK, Association of Researchers in Construction Management, 237-246.*
- Adjei, S., Ankrah, N., Ndekugri, I., and Searle, D. (2015) Voluntary Compliance and Regulatory Enforcement: the case of the English Site waste management Plans (2008) Regulations *In Proceedings of 12<sup>th</sup> International Post-Graduate Research Conference, (IPGRC 2015), 10-12 June 2015, Media City, UK, 821-829.*
- Adjei, S., Ankrah, N. A., and Ndekugri, I. E. (2013) Review of construction and demolition waste management legislation in the UK *RICS COBRA 2013 Research Conference, New Delhi, India 10- 12 September.*

#### ABSTRACT ACCEPTED

- Adjei, S, Ankrah, N, Ndekugri, I and Searle, D (2016) Factors influencing sustainable CD&E waste management *Procs 32nd Annual ARCOM Conference, 5-7 September 2016, Manchester, UK, Association of Researchers in Construction Management.*

## APPENDIX 2

### Data Collection Plan

This research employs a multiple case study design to enable a rich insight into the construction and demolition waste management (WM) practices of firms. The aim is to purposefully select cases that reflect good waste management practices undertaken by construction firms. To enable a better understanding of the waste management practices, focus will be on three main areas: reasons for the practices (the decisions leading to these practices); the practices undertaken; and their outcomes. A summary data collection plan is provided below.

ITEM/INSTRUMENT		DESCRIPTION	RATIONAL	SOURCE/LOCATION
<b>A</b>	Preliminary Interviews	Preliminary discussions with construction firms to understand their waste management practices and processes.	This is to help give a general understanding of the waste management practices and kind of information accessible for the purpose of this research. Also intended to get the input of firms in the design of the data collection instruments. This will help to fine-tune the instrument to ensure it targets the correct sources and asks the most relevant questions	Project managers; corporate websites/publications
<b>B</b>	Project Information Sheet	A simple questionnaire for recording project specific information (project type,	This is expected to provide information relating to the uniqueness of cases and how	Project Managers/site managers; project

## APPENDICES

		size, client type, etc.)	this affects waste management practices/decisions. It is also expected to provide a basis for discussing results from the case studies	reports
<b>C</b>	Waste Management Considerations	Interviews and documentary analysis on the decisions leading to waste management policies or waste management practices. This is to cover considerations of firms regarding waste management practices and factors affecting these considerations	This is aimed at determining the various factors affecting waste management decisions which in turn lead to practices. The rational is to understand the reasons behind waste management practices which will give an indication of their expected outcomes.	Interviews (waste managers/project or site managers/ waste); management policy; written reports and communications.
<b>D</b>	Waste management practices	This is to explore the waste management practices of firms by way of interviews coupled with direct observations and documentary analysis where possible.	The rational is to document the practices employed by construction firms to manage construction and demolition waste. This is intended to capture practices which will form the basis for determining the outcome of firm level practices.	Interviews (project managers/site managers/waste managers); direct observation; site waste management plans; other documentary

## APPENDICES

				analysis
<b>F</b>	Waste management Outcomes	Interviews and analyses to explore the outcome from the waste management practices of construction firms. focus of this section is on the results of waste management practices and what	Rational is to set the basis for comparing the outcomes of waste management practices to the intended outcomes of waste management legislation and policy.	Interviews; direct observations; project reports; site waste management plans; other documentary analysis

## APPENDIX 3

### RESEARCH PROPOSAL TO COMPANIES



#### RESEARCH ON CONTRUCTION AND DEMOLITION WASTE MANAGEMENT

### RESEARCH PROPOSAL

#### Introduction

The construction industry for decades has been termed environmentally non-friendly due to the effects the activities of the industry have on the environment by the use of excessive amounts of natural resources and the production of waste which harms the environment. To reduce the negative impacts of the industry on the environment, efforts have been made by governments, business producing waste and academia. Currently there are a number of government legislation targeted at construction firms to ensure they manage the waste they produce. Construction firms on the other hand have been developing techniques and practices to manage waste to ensure compliance with legislation and to reduce the negative impact of the industry on the environment. There is a growing body of evidence to suggest that managing construction and demolition waste does not only result in positive environmental effects but also has the potential to result in cost savings to construction firms.

#### Research Questions

Though majority of the research on waste management within the construction industry suggest that legislation is a critical factor in ensuring the sustainable management of waste by the industry, evidence of studies exploring the extent to which practices of firms meet the intended outcomes set by legislation are not present in the literature. Based on this revelations, this research seeks to answer the following fundamental questions:

- how does construction and demolition waste management legislation and policy in the UK translate into practice? – What system of enforcement is employed by the regulators, what are the policies of firms, what resources are employed and what are the cost implications for waste management?
- what are the waste management practices of construction firms and what outcomes do they achieve?
- currently to what extent have the goals of the interventions been achieved by the firms?
- how adequate are the practices of construction firms in meeting the targets set by the legislative framework?



**Study approach**

To explore these research questions, this study employs a case study approach where interviews would be conducted with waste managers and decision makers on the considerations affecting waste management decisions and practices. To better capture waste management practices and their outcomes, observations would be made during project execution to understand how decisions lead to practices and the outcomes such practices derive.

**Expected Outcomes**

At the end of this study, it is expected that a deeper insight into the subject of construction and demolition waste management will be gained which will lead to recommendations for managerial action. For your participation, any framework or guidelines for sustainable waste management practices produced from the findings of this research will be made available to your firm. As an industry leader buying into the sustainable construction agenda, it is anticipated that the results will prove useful to your firm in helping pursue sustainable waste management which will not only help you comply with waste legislation, but also bring cost savings to your firm.

## APPENDIX 4

### INVITATION TO PARTICIPATE IN RESEARCH

Dear Madam,

REQUEST FOR ASSISTANCE WITH RESEARCH ON CONSTRUCTION AND DEMOLITION WASTE  
MANAGEMENT

I am undertaking a doctoral research into waste management practices in the construction industry. The aim of the research is to develop a framework for waste management best practice.

To achieve this aim, access to projects and practitioners is necessary. We believe that as winners of the Building Magazine Project of the Year during the Building Awards 2013, you are very well placed to support this project with the needed access for the following purposes:

- visits to the project site to observe waste management practices;
- interviews with key waste management personnel;
- examining samples of waste management documentation.

All data gathered will be treated with strict confidentiality and will be destroyed upon completion of the research. At no instance would the true identity of any interviewee or organisation be linked to any responses provided and the entire research process would be conducted in accordance with the University of Wolverhampton's ethical and safety guidelines for fieldwork. In return for your participation, any tools, instruments and guidelines on waste management that will be developed based on findings from across the construction industry will be made available to your firm. I am also willing to comply with any requirements or negotiate any terms that you may deem necessary in accordance with your company's regulations.

This research is being conducted under the supervision of Dr Nii A. Ankrah ([nii.ankrah2@wlv.ac.uk](mailto:nii.ankrah2@wlv.ac.uk)) and Professor Issaka Ndekugri ([I.E.Ndekugri@wlv.ac.uk](mailto:I.E.Ndekugri@wlv.ac.uk)). To indicate the willingness of your firm to participate in this research, kindly send an e-mail to [Solomon.adjei@wlv.ac.uk](mailto:Solomon.adjei@wlv.ac.uk) or complete and return the enclosed form providing details of a contact person with whom further correspondence should be made. A brief synopsis of the study is attached for your information.

Thank you in advance for your consideration and I look forward to obtaining a favourable response.

Yours faithfully,

Solomon Adjei (Researcher)

Tel:

## APPENDIX 5

## CONTACT PERSON FORM



Faculty of Science and Engineering

University of Wolverhampton

Technology Centre

**RESEARCH ON CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT**

I would be very grateful if you could provide details of a contact person with whom further arrangement can be made regarding the case study access. This can be posted back using the enclosed FREE POST return envelope. Alternatively, details of contact person can be sent by e-mail to [Solomon.adjei@wlv.ac.uk](mailto:Solomon.adjei@wlv.ac.uk)

**CONTACT PERSON DETAILS**

<i>Name of company</i>	
<i>Name of contact person</i>	
<i>Position of contact person</i>	
<i>Email contact</i>	
<i>Telephone contact</i>	

Completed by: \_\_\_\_\_

## APPENDIX 6

### DETAILED REQUIREMENTS FOR CASE STUDIES

#### Detailed requirements for case studies

The aim of the case study is to investigate the waste management practices of construction firms with emphasis on how they meet the obligations of waste management legislation.

The case study targets three main areas.

1. Management Level Decision Making on Construction and Demolition waste Management
2. Project Level waste management Practices
3. Outcomes from waste management Practices

#### Management Level Decision Making

This phase of the case study seeks to explore waste management strategy at the organisational level to develop some understanding of the drivers of site level practices. The focus is to investigate the various factors affecting decision making at that strategic level and the roles played by key personnel in the decision making process. It also seeks to explore how the decisions translate into waste/environmental/sustainable management policy of the company and how such policies are implemented in practice. Special emphasis will be given to the consideration given to waste management legislation.

For information to these questions, the following accesses will be required:

- a. interview with a key person/s in charge of waste management strategy/decisions (preferably waste manager/environmental manager) to last approximate 1 hour;
- b. access to company environmental/waste management policy document; and
- c. any other documents relating to waste management strategy.

#### Project Level Waste Management Practices

This investigates the waste management practices of the company at the project level. The main aim is to investigate how the waste management strategy or policy translates into project level

waste management actions/practices. Emphasis will be on practices that are targeted at waste elimination/reduction/reuse/recycling/recovery and disposal. Because this is project level, the focus will be on a particular project/s and the practices adopted. Focus will also be on how the changes in waste management legislation (Scrapping of the Site Waste Management Plan 2008) have affected (or will affect) the waste management practices at project level.

For the purposes of these requirements, the following access will be required:

- a. access to live project/s to observe waste management activities;
- b. interview/s with key personnel in charge of waste management at the project level (to last approximately one hour);
- c. interviews with key operatives and subcontractor personnel to gain some insight into their perceptions of the site waste management practices (to last approximately 30 minutes each);
- d. access to waste management documentation at the project level (plans, memos, bulletins); and
- e. admission to onsite waste management training or tool box talks where possible

### **Outcomes from Waste Management Practices**

The final part of the case study will explore the outcomes of waste management practices adopted on the project. This will seek answers to questions of how the company measures their waste management performance and outcomes. Outcomes from the live projects (expected outcomes) will also be compared with outcomes of similar projects over the past few years.

In this regard, the following access will be required:

- a. interview with personnel in charge of waste management at the project level;
- b. access to waste management data and transfer notes on the current project; and
- c. access to waste management documents of completed projects

## CONSIDERATIONS FOR WASTE MANAGEMENT

**APPENDIX 7****PROJECT DATA SHEET AND SUMMARY FORMS****7A PROJECT DATA SHEET****PROJECT DATA SHEET**

	CASE STUDY PROJECT INFORMATION
Project Type	
Project Size (Sum)	
Type of Contract	
Type of Client	
Project Duration	
Progress at time of case study	

## 7B CONTACT SUMMARY SHEET

[illegible]

## 7C DOCUMENT SUMMARY FORM

	DOCUMENT CODE:
DOCUMENT TITLE: .....	
CASE STUDY COMPANY: .....	DATE:
CORPORATE/PROJECT LEVEL DOCUMENT .....	
PROJECT ATTACHED: .....	PROJECT LOCATION: .....
SIGNIFICANCE OF DOCUMENT TO WASTE MANAGEMENT: ..... .....	
MAIN USERS OF DOCUMENT: .....	
KEY INFORMATION/REQUIREMENT OF DOCUMENT	



7D OBSERVATION SUMMARY FORM

DOCUMENT CODE:

PROJECT TITLE: .....

CASE STUDY COMPANY: .....

DATE OF VISIT: .....

DURATION OF VISIT: .....

PROJECT SITE SPACE: .....

SEGREGATION ON SITE? .....

PEOPLE/WORK SECTIONS OBSERVED: .....

.....

PERSONNEL INVOLVED WITH OBSERVATIONS

.....

NOTABLE OBSERVATIONS

## APPENDIX 8

### INTERVIEW GUIDE FOR CORPORATE PERSONNEL

#### Interviewee information

**INF 1** Your position in the firm? .....

**INF 2** How long have you been working with this firm? .....

**INF 3** What role are you playing on this project? .....

#### Waste Management information

**WMG 1** How are waste management decisions in your firm arrived at? Is there a general laid down plan for waste management, or decisions are project based only?

**WMG 2** Is there a specific laid down waste management policy for your firm? Or waste falls under the environmental policy?

**WMG 3** What would you say affects the decisions regarding your waste management policy? What are the major drivers of these decisions? Is it possible to categorize these decisions into regulatory, social, economic and resource considerations?

**WMG 4** Regarding regulatory considerations, how do you ensure that all legislative obligations are covered? (Considering the changing nature of UK regulations).

**WMG 5** What motivates your firm to comply with legislative requirements? To what levels do the following affect your regulatory compliance efforts: Fear of punishment for non-compliance; believe in the legitimacy of regulations; and social pressure to comply with regulations.

**WMG 6** Are there some waste management actions (practices) your firm would rather not do if not to meet legislative obligations?

**WMG 7** Are there specific resources that you must acquire just to meet regulatory demands? (materials, human, time, equipment) What is the cost to your firm for complying with waste management regulations? How are costs of compliance calculated?

**WMG 8** In terms of cost and benefits, which would you say regulatory compliance give you? More costs or more benefits?

**WMG 9** Aside regulatory requirements, are there other social pressures to manage waste? What are the sources of these pressures and what demands do they come with? Why do these sources of social pressure matter to you?

- WMG 10** How do you ensure these social demands are met and what influences do these social pressures have on your business?
- WMG 11** To what extent does resource requirements affect your overall waste management activities? What are the general resource requirements for managing waste and how do you ensure all required resources are available to your firm?
- WMG 12** Are there specific resources for particular waste management activities? What happens when such resources are not available?
- WMG 13** Which resource features most in your waste management efforts (materials, human, equipment, time)? Which of these do you readily have most often?
- WMG 14** How does financial concerns (economic) affect your waste management decisions? Would you say waste management gives you more cost than benefits? Please explain
- WMG 15** How do you measure/calculate the cost and benefits of your waste management efforts? What are the possible sources of cost and benefits for waste management?
- WMG 16** In deciding on waste management policies/practices, to what extent do the categories discussed above influence your decisions? Can you rank them in order of the highest influence (cost, resources, regulatory and social pressure)? Are these rankings fixed or they change based on the projects?
- WMG 17** Is there any relationship between the project/client served and the waste management considerations? Please explain.
- WMG 18** How do you ensure that these considerations are transferred to the waste management practices adopted on site?

## APPENDIX 9

### INTERVIEW GUIDE FOR PROJECT LEVEL STAFF

#### WASTE MANAGEMENT PRACTICES – PROJECT LEVEL

##### Interviewee information

**INF 1** How long have you been working with this firm? .....

**INF 2** What is your position/role on this project? ..... How long have you been in this position? .....

##### Waste Management information

**WMG 1** What is the general structure of waste management practices in your firm?  
DO you have a specific person in charge of waste management and if yes, what are the roles? (If no, who takes charge of waste management efforts?)

**WMG 2** When do you begin waste management practices and what is usually the first point of call? What early planning activities do you embark on if any?

**WMG 3** Are you involved during the design stage of projects? If yes, what inputs are made concerning designing to reduce waste? Are there specific design considerations known to positively affect waste management during the construction stage of projects?

**WMG 4** Are waste management contractors involved in your waste management efforts? If so, at what stage of the project are they contracted and what impact does this have on your activities?

**WMG 5** What would you say are the main duties/roles of waste management contractors on your projects?

**WMG 6** Are there particular waste management methodologies adopted on site? (Example a site waste management plan) who prepares this and what goes into this process?

**WMG 7** Can you easily group your waste management practices into categories or sections? (reduction practices, reuse practices, recycling practices, recovery practices and disposal practices)

**WMG 8** As a start to managing waste on site, how do you determine the amount of waste expected? How critical is this to the practices adopted on site to manage the

waste during the project phase? Are there specific categories of waste desiring extra attention and how do you arrive at this?

**WMG 9** How do you ensure that the waste management decisions are communicated to all members on the project? Are there specific waste management training sessions for site staff? How are these designed and when do they take place?

**WMG 10** As a firm, are there some specific in house practices/technologies adopted to ensure waste generation is reduced? (Are there particular construction/demolition techniques adopted to prevent the generation of waste?)

**WMG 11** How do you ensure materials are handled on site to prevent the production of unnecessary waste? Are there specific procedures to handle specific materials to prevent waste?

**WMG 12** Are your waste management practices materials based or activities based? Do you have specific waste management practices for specific materials? Can you kindly elaborate on this if possible?

**WMG 13** Are there particular practices solely targeted at waste management legislation? How different would these practices be if legislation did not require you to do so? Would you say legislative obligations make waste management practices any better?

## APPENDIX 10

### VALIDATION QUESTIONS

#### Corporate Level Waste Management

Please take some time to respond to these questions to validate claims made by the research on the corporate level waste management in your company.

##### Company Vision

1. Does the vision stated for waste management at the corporate level of your company the report reflect your company's waste management vision?

##### Drivers for Waste Management

2. Do the drivers shown in report give a clear picture of the nature and extent of drivers influencing waste management at the corporate level of your company?
  - a. If no, what are the main drivers for waste management at the corporate level of your company?

##### Approaches to managing waste

3. As part of the company's at the corporate level towards waste management, do you approach waste management with the design, procurement and construction level approaches as shown in the report?
  - a. Are there any other approaches to managing waste at the design, procurement and construction phases of your company's

##### Strategies for waste management at the corporate level

##### *Planning*

4. Does the strategy for planning waste management at the corporate level of your company require senior management on projects to use the waste hierarchy and appoint a waste champion as shown in the report?

### *Outsourcing*

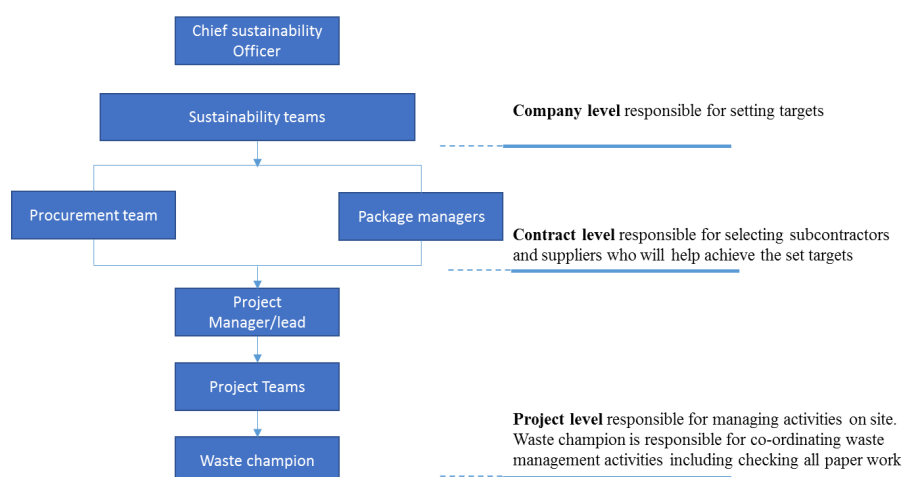
5. Are there only two approaches to outsourcing waste management as shown in the report?

### *Monitoring of waste management*

6. Do you use an integrated waste management system, a waste targets and monitoring form for setting targets and senior management as the means to monitor waste management on your projects as claimed by this research?

### *Governance for waste management*

7. Does the figure below clearly represent the hierarchy for waste management at the corporate level of your company?



If no, can you describe the hierarchy for waste management at the corporate level of your company?

### *Training and education for waste management*

8. Does the strategy towards training and education rely on toolbox talks and site inductions only as presented in the report?

**PROJECT LEVEL WASTE MANAGEMENT**

9. Does the report on the management structure for waste management on projects reflect the reality on your projects? Any comments
10. Does the process for planning waste management shown in the report reflect practices on your construction projects?
11. Project teams are at liberty to adopt a best practice approach to managing waste on your projects. Please comment on this finding
12. Waste management on your construction projects rely on design strategies, procurement strategies, demolition strategies, construction strategies or technologies; and management strategies. Please comment on this finding.



## APPENDIX 11

### FRAMEWORK EVALUATION QUESTIONNAIRE

#### PROPOSED BEST PRACTICE FRAMEWORK FOR SUSTAINABLE CONSTRUCTION, DEMOLITION AND EXCAVATION WASTE MANAGEMENT

##### Framework Evaluation Questions

In relation to the logic and usefulness of the proposed framework for sustainable management of construction, demolition and excavation waste management, a number of statements have been made below. Kindly provide us with feedback on the proposed framework by completing the comment fields.

1. Do the main elements identified in the framework adequately capture the CD&E waste management practices of main contractors and their influences on achieving sustainable management of waste?

1.1 Are the inter-relationships between the main elements in the framework reflective of the situation in practice?

1.2 To what extent do the contextual factors identified in the framework influence your organisation's implementation of sustainable CD&E waste management during projects?

2. Does the framework provide a structured, well-informed and holistic approach for implementing CD&E waste management?

2.1 Can the framework serve as an appropriate roadmap for other main contractors to implement sustainable CD&E waste management?

2.2 What can your organisation do to further entrench the CD&E waste management elements identified in the framework especially sustainable CD&E waste management initiatives?

3. If the framework implementation guide is followed, will this facilitate sustainable management of CD&E waste by the construction companies?

4. Are the recommendations put forth as part of this framework complete?

4.1 Are there any particular barriers that hinder the implementation of recommendations put forth as part of this framework?

4.2 Are there any additional recommendations that can be suggested to further enhance supply chain management implementation in a main contractor's organisation?

**Thank you**

## APPENDIX 12 ETHICS FORMS

## UNIVERSITY OF WOLVERHAMPTON

## SCHOOL OF TECHNOLOGY

## ETHICAL CONSIDERATION FOR RESEARCH PROGRAMMES

Section 1: Your details			
<b>First Name &amp; Surname:</b>	SOLOMON D. ADJEI	<b>Student No:</b>	1129095
<b>Project Title</b>	REVIEW OF WASTE MANAGEMENT IN THE UK CONSTRUCTION INDUSTRY		
<b>Director of Studies:</b>	Dr NII A. ANKRAH		

Section 2: Your Project Topic	
<p><b>2.1</b> What problem is this project addressing? (100 words or less)</p> <p>This research addresses the issue of excess generation of construction, demolition and excavation (CD&amp;E) waste and the negative influence it has on the environment, natural resources and the profitability of construction firms. The aim is to investigate current practices of CD&amp;E waste management in relation to the extent to which they meet the intended outcomes of legislation and relevant policy documents and to suggest an agenda for improvement action</p>	
<p><b>2.2</b> Will information or artefacts resulting from your project be available externally to the University?</p>	Yes
<p><b>2.2.1</b></p> <p><b>If you answered 'yes' to 2.2,</b></p> <p>Will any such information place anyone at risk or possibly result in any action that might be detrimental to their wellbeing? (See guidelines)</p>	<p>No. The information obtained is strictly for academic purposes and poses no risk to the well-being of participants as stated in Section 1: Category A1 of the ethics approval guidelines. Electronic copy of dissertation to be kept in the learning centre and could be accessed by others but no confidential</p>

	information, such as transcribed excerpts will be included.
<b>2.2.2</b>  In what format will the information or artefacts be made available?	Publications in academic journals, conference proceedings and databases such as Ethos and WIRE.

**Please attach samples with this form if you intend to do interviews, surveys, or questionnaires.**

**3.1** Does any part of your proposed project involve human participants?

Yes

**If 'no' proceed to section 4**

**3.2**

Please explain any aspects of the project, which might be detrimental to the wellbeing of any human participants in your project.

No aspect of this project is detrimental to the wellbeing of human participants. Interviews will be codified for data protection purposes and this will ensure anonymity of all participants in this research.

**3.3**

Are there other ways you might meet your project aims without involving human participants? If not, why?

No other ways.

This is because this research investigates the waste management practices of construction firms which is only possible by engaging the firms and their workers. For this reason, this research cannot be conducted without human participants.

**3.4**

How will you select your participants?

Direct contacts will be made to the construction companies through letters and emails seeking access to

<p>their projects for the purposes of this research. Four companies will be selected for the purposes of this research. Within each company, the specific participants will be selected based on job roles</p>	
<p><b>3.5</b></p> <p>How many participants will you contact? About 50 – for interviews</p>	
<p><b>3.6</b></p> <p>How will you approach potential participants? E.g. email, letter, face to face? Please append text of any letter or email? Participants for the interviews</p> <p>Participants will be contacted via emails and post to indicate their willingness to participate in this research after they have been given proposals indicating the aim and objectives of the research and the role they are likely to play should they opt to be part.</p>	
<p><b>3.7</b></p> <p>Are your participants adults? (over 18 and competent to give consent) If no, answer 3.7.1. (See guidelines)</p> <p>Yes.</p>	
<p><b>3.7.1</b></p> <p>Are your participant's children or adults under 18 and not competent to give consent? If yes, why is it necessary to involve these participants?</p>	<p>No.</p>
<p><b>3.8</b></p> <p>Are you offering any incentives to any of your participants, financial or otherwise? (See guidelines)</p>	<p>No.</p>
<p><b>3.9</b></p> <p>How much time do you estimate will be</p>	<p>Interviews- 45 Minutes per participant</p>

needed from any participants? (See guidelines)	
<b>3.10</b>  Please list the method of data collection and analysis intended to be used  <div> <input checked="" type="checkbox"/> Interviews, documentary analysis and passive observations  <input checked="" type="checkbox"/> Analysis of all data will be conducted using QSR NVivo and will include coding, categorisation, pattern matching and thematic analysis.         </div>	
<b>3.11</b>  Will all of the data collected contribute towards your results?	Yes.

#### Section 4: Confidentiality and data handling

Please read methods of ensuring confidentiality in the guidelines.

4.1 Will you ensure the anonymity of data collected from/and about participants?	Yes
--	-----

4.1.1 Please explain how this will be achieved.

Codes to represent the construction firms and their participants will ensure no trace will be made to the participants

4.2 Will you store/protect data collected from individuals e.g. password protected files?	Yes
---	-----

<b>4.3</b> Once your project is complete and information is no longer needed, will you destroy your data?	Yes
<b>4.4</b> Will anyone else have access to the data collected?	Yes
<b>If so,</b>  (i) please name the individuals and/or groups that will have access;  (ii) why is access being given to those listed in (i)?	Dr Nii A Ankrah (DOS)  Professor Ndekugri Issaka  They are my supervisors.
<b>Section 5: Working with other parties and companies</b>	
<b>5.1</b> Will you be using data on subjects held by another party or organisation?	No
<b>If Yes,</b>  (i) Please give details.  (ii) How will you gain access to this information?	
<b>5.2</b> Do you require written permission from a company, organisation or location, e.g. an employer or local authority?	No
<b>If Yes,</b>  (i) Please complete an <a href="#">external agreement form</a> and include this with your submission.	
<b>NB: If working with another organisation or company please familiarise yourself with their Health &amp; Safety procedures.</b>	

**Things you must be aware of:**

**Data Protection Act:** [http://www.ico.gov.uk/what\\_we\\_cover/data\\_protection.aspx](http://www.ico.gov.uk/what_we_cover/data_protection.aspx)

**Freedom of Information Act:** [http://www.opsi.gov.uk/Acts/acts2000/ukpga\\_20000036\\_en\\_1](http://www.opsi.gov.uk/Acts/acts2000/ukpga_20000036_en_1)

[University of Wolverhampton Ethical Approval Procedural Guidelines](#)

**Checklist:**

1. If you are using a questionnaire or interview sheet please include a list of sample questions with your submission.
2. In addition, please include an introductory cover letter stating some information about you, your project proposal and how your data will be used.
3. If you are undertaking a project involving a company or organisation you will need to show that you have approval from that organisation. Please include a completed copy of the [External Agreement Form](#).

**Student's Declaration**

Sign and date against **one** declaration **only you need to sign one of these**

**Category 0.**

My project involves no human participation except for myself and I agree to ensure that any information or artefact produced will not be available outside the University.

**Category A1.**

My project involves limited human participation and I agree to ensure that

- (i) any such participation is not detrimental in any way to the interests of the participants;
- (ii) all information collected as a part of the project will be handled in accordance with the answers that I gave to question 4;
- (iii) No information or artefacts which may place anyone at risk or be detrimental to their wellbeing will be made available outside the University.

**Category A2.**

My project involves human participation and may present some risk to participants. I have considered alternative means of pursuing the project which do not entail this risk but believe that there is no practicable alternative. I agree to ensure that I take all necessary steps to minimise risks to participants and third parties. I agree not to proceed with any activities involving human participation until I

have received approval from the Department Ethics Panel.	
<b>Category B-E.</b> My project does not conform to Category 0, A1 or A2. I have considered alternative means of pursuing the project which do not entail risk to human participants but believe that there is no practicable alternative to the proposal made. I agree to ensure that I take all necessary steps to minimise risks to participants. I agree not to proceed with any activities involving human participation until I have received approval from the School or University Ethics Committee, as appropriate.	

<b>Director of Studies/Principal Investigator's Declaration</b>	
Sign and date against <b>one</b> declaration <b>only</b>	
<b>Category 0 or A1.</b> I concur with the classification of this project as <b>0</b> or <b>A1</b> and authorise continuation of the project pending consideration by the School Ethics Committee	
<b>Other.</b> I believe that this project should be classified other than <b>0</b> or <b>A1</b> . I will ensure that no activities involving human participants take place until and unless approval is granted by the School Ethics Committee	

## FOR SUPERVISOR/PANEL/COMMITTEE USE ONLY:

CLASSIFICATION ALLOCATED BY SUPERVISOR				
0, A1		Supervisor Action: Authorise and forward to SEC	Date	
		Supervisor Action: Refer to DEP for decision	Date	
Other	CLASSIFICATION ALLOCATED BY SCHOOL ETHICS COMMITTEE			
	0, A1		SEC Action: Continuation of project approved	Date
	A2, B		Considered by SEC below	Date



		<b>2.3</b> Is any risk associated with access to project acceptable in context? If no, give reasons below:				Yes		No			
		<b>3.1</b> Is involvement of human participants justified? If no, give reasons below:				Yes		No			
		<b>3.3</b> Is experimental method acceptable with regard to risk and inconvenience to participants? If no, give reasons below:				Yes		No			
		<b>4</b> Are arrangements for confidentiality and data protection appropriate? If no, give reasons below				Yes		No			
		<b>5</b> Do arrangements for working with external bodies protect interests of participants and the external bodies? If no, give reasons below				Yes		No			
		<b>SEC Action:</b> Continuation of project approved:				Yes		No		Date	
		Conditions:									
	<b>Other</b>	<b>SEC Action:</b> Refer to University Ethics Committee							Date		

## Guidelines

### Section 1: Categorisation for ethical approval

**Category 0:** There are no third parties directly involved in the project and any artefacts produced by the project will not be accessible to a general audience.

#### Category A1

Projects involving human volunteers are involved solely for the purposes of:

- providing data to inform the specification of an artefact
- testing the usability or fitness for purpose of an artefact

where the nature of that artefact or its use will present no risk to the volunteers

and, if any artefact is accessible to a general audience, access to that artefact will present no risk.

#### Category A2

Projects involving human volunteers other than those defined in category A1 but not in activities defined in other categories or if any artefact is accessible to a general audience, access to that artefact may present some risk.

#### Category B

Projects involving human volunteers including potential risk, for instance, studies using new research methodologies, studies involving certain vulnerable populations or therapeutic interventions or other significant risk to anyone involved in the research (but not including trials of artefacts intended for therapeutic purposes).

#### Category C

Research being conducted by staff or postgraduate research students involving

Patients, clients staff, records etc. within the sphere of the NHS, Social Services, etc (but not including clinical trials of medicinal or related products).

#### Category D

Research being conducted by undergraduate or taught postgraduate students involving

Patients, clients staff, records etc. within the sphere of the NHS, Social Services, etc (but not including clinical trials of medicinal or related products).

#### Category E

Clinical trials of medicinal or related products involving patients or healthy volunteers as direct users of the product.

**Question 2.2.1:** You should answer yes if your artefact, product or information might be of direct risk or might lead or encourage people to alter their behaviour in a way which would be detrimental to them. Examples of direct potential risk might be a machine that could injure someone if it malfunctioned or a web resource which contained information which if it was misused would lead to risk (for instance, children's identities or addresses). Examples of artefacts which might encourage detrimental behaviour could be a web resource offering alternatives to expert (such as GP or lawyer) advice or products which purport to have a therapeutic effect.

**Question 3.7.:** As a general principle, all participants should be informed of their role in the experiment and freely consent (in writing) to it, which implies competence to give consent. Very occasionally it may be necessary to undertake an experiment without consent, or with participants who are not competent but then any decision about the acceptability of the proposal would be taken on the basis of the absolute benefit of the experiment in a wider context, and it would have to be established that there was no alternative.

**Question 3.8:** With regard to freedom of consent, it is likely that this principle would be breached if the participants were subject to some kind of inducement or coercion, however minor. For instance, it is likely that participants who were under the management of the person undertaking the experiment would be considered to be under a degree of coercion.

**Question 3.9:** It may be considered that expecting a participant to spend undue time or effort participating in an experiment would be detrimental to the interests of that person, particularly where the results of the work offered no clear benefits. It may be appropriate to compensate participants for their time, but it is not acceptable to offer inducements to participate.

#### **Section 4 Anonymity:**

It is to be expected that due care and attention be paid to protecting information about individuals. Depending on the nature of the experiment, the following may be considered.

- Type 1: Complete anonymity of participants (i.e., You will not meet, or know the identity of participants, as they are part of a random sample and are required to return responses with no form of personal identification)?

- Type 2: Anonymised samples or data (i.e., an irreversible process whereby identifiers are removed from data and replaced by a code, with no record retained of how the code relates to the identifiers. It is then impossible to identify the individual to whom the sample of information relates)?
- Type 3: De-identified samples or data (i.e., a *reversible* process whereby identifiers are replaced by a code, to which you retain the key, in a secure location)?
- Type 4: Subjects being referred to by pseudonym in any publication arising from the project?
- Type 5: Any other method of protecting the privacy of participants? (eg. use of direct quotes with specific, written permission only; use of real name with specific, written permission only)